Electric Impulse Apparatus for Chicken Culture.

Height 1' 0"
Length 8' 0" (exclusive of Sleeping box)
Width 5' 6"

Top flat of Intensive Chicken House showing how the wire is carried round and round two sides (only one side is seen in the illustration). The wire passes over as depicted, and in the bottom flat is passed along the top of the floor. (Each House has 6 flats.)

Switch

Condensers

Coil

Cutout Switch

Intensive Chicken House holding 400 electrified chickens (6 Flats).

Electrified Chickens at feeding time.

By courtesy of the Illustrated London News.

Incubating up-to-date.

HATCHING CHICKENS BY ELECTRICITY.—[See page 63.]

Gyroscopic Force in Revolving-Cylinder Motors

Suggestions Relating to the Improvement of Stability by Altering the Position of Their Axes of Rotation

By Noel Deisch

THERE has been so much confusing controversy, and so many conflicting opinions have been expressed as to the exact extent and influence of gyroscopic force in revolving-cylinder internal-combustion aeronautic motors, that it has seemed opportune to give a clear and exact statement of the action of this force in engines of the above description, and finally to see if it is possible so to dispose a rotating power plant that the stresses produced may not militate against proper control, but may actually aid, especially in turbulent air, the preservation of equilibrium. Though the question of this force as a cause of accidents had been touched upon by various commentators upon the subject from the time of the earliest use of the revolving engine, it was not until the death of Miss Quimby that it received popular attention, and Paul Peck's tragic decease renewed the discussion, which returned in such a virulent form that some of the most reputable scientific journals saw fit to close their correspondence columns to argumentation on the subject. However, it is now generally admitted that while in normal flight no inconvenience may be experienced, still, under certain conditions of flight and wind—notably in the "spiral dive" and in sudden disturbances due to "air holes" and other rapid and unexpected currents of air—gyroscopic force may take a not inconsiderable part in the confusion of the operator, if not, in some cases, actually nullifying the action of stabilizing devices provided for the maintenance of equilibrium.

The present article will not treat of the actual stresses produced by gyroscopic action, nor of the mathematical calculations involved in their determination (which have already been fully elucidated in this magazine[1]) but instead, of their particular effect upon equilibrium under differing relative positions, and directions of rotation, of the motor. For those who do not understand the method of determining the direction of precession caused by different primary stresses, and also to aid the imagination, diagrams are given, and the forces have been conveniently represented by means of arrows. A black arrow indicates the direction of the applied force, and the unshaded arrow the resulting tendency due to precession, the small arrows in the disks representing the direction of rotation of the motor.

With the last as ordinarily positioned, i. e., with its axis of rotation parallel to the direction of flight, two possible cases present themselves, according as the direction of rotation of the engine is to the right or to the left. The Gnome engine revolves counter-clockwise (to an observer stationed in front of the machine) and Fig. 1 represents what will occur to an aeroplane fitted with this engine under different conditions. An inspection of the aforementioned figure will show that in descending, the machine would tend to turn to the left, while in

Fig. 1.—A Gnôme-engined machine descending. It turns to the left.

ascending it would tend, of course, to turn to the right. Likewise a right-turn or a sharp wind-gust striking the machine's right wing from the front would cause a tendency to dive, conversely a left-turn or a gust striking the left wing from the same direction would cause a tendency to ascend. With the motor revolving clockwise the behavior of the aeroplane under similar conditions would simply be reversed.

Another position that would suggest itself is that with the axis of rotation vertical, the propeller being driven by means of bevel gears as shown in Fig. 2.

Fig. 2.—A descent with this machine would cause the depression of the right wing.

[1]SCIENTIFIC AMERICAN SUPPLEMENT, No. 1946.

This was the arrangement employed in mounting the Salmson motor on the Astra biplane exhibited at the hydroaeroplane meet at Monaco, a position at once seen to be most unsatisfactory, any canting of the machine due to air currents causing a tendency to pitch longitudinally, and likewise an ascent or descent causing destruction of lateral equilibrium. The propeller would also introduce unbalancing factors which are not dealt with.

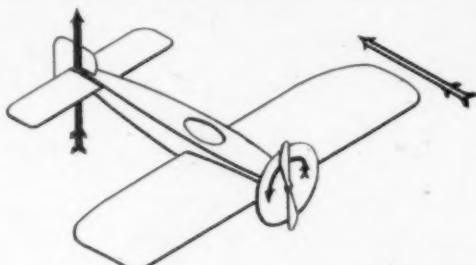It must be understood that in all the arrangements considered there is a distinct resistance to any disturbing force, and if it were not for the secondary effects, gyroscopic force in motors would be decidedly of advantage to the aviator instead of being, as it is, a menace to him. Neither must one lose sight of the fact that the revolving motor must not be considered a strictly "passive" gyroscope, because an aeroplane is so delicately poised that some liberty of movement is allowed, and hence the motor-gyroscope becomes "active" and the precessional effects are intensified. It will now be seen that if the motor could be so disposed that these disturbing factors would be made to serve a useful purpose the much discussed problem would be disposed of, and the last objection to the use of these excellent motors, which have so many valuable features to commend them, would be put to rest forever. An examination of the accompanying diagrams (Figs. 3 to 5) will indicate a totally new arrangement which fulfills all the requirements mentioned, besides possessing secondary advantages of great value, and the problem may therefore be considered solved. This novel disposition is simply that of placing the axis of rotation of the motor parallel to the direction of the wings' lateral extension, the direction of rotation being such that its upper cylinders are moving opposite to the direction of flight, and the propellers—for there would be two in the type of machine which we are considering—revolving in opposite directions so that their contrarily-acting forces would be balanced and therefore nullified.

We will first consider the effect of thus positioning the engine upon its gyroscopic action, leaving other practical features, such as mounting, etc., for later consideration. A glance will show that rising or descending can produce absolutely no precessional effect, and conversely that there can be no such effect which could unbalance the machine longitudinally or cause the sudden "dive" which has so often proven disastrous. This latter is sometimes caused by suddenly turning, or being turned by a wind-gust, and as no maneuver is commoner, it is consequently of the greatest importance to the aviator that no inconvenience should follow under even the most trying circumstances. Some authorities of reputation have held that Miss Quimby's death was the result of a turn, executed to the left, and probably caused by a sudden gust of wind, the powerful downward impulse given by gyroscopic action throwing the aviatress and her passenger to the front, catapult like, entirely clear of her machine. No such consequence could follow upon a turn, either intentional or accidental, with the mounting described. However quickly it might be executed, the result would simply be automatic banking—a very desirable feature. This is shown in Fig. 4.

It being evident that with the arrangement considered, a wind-gust could not unbalance the machine longitudinally, it will be interesting to ascertain its exact effect upon lateral equilibrium, remembering at the same time that one wing must be affected more than the other to produce any result other

than merely that of lifting the machine. When one wing is so affected, however, the consequence will be a turning of the aeroplane on its vertical axis toward that side on which the greatest force is exerted. In other words, it will turn into the wind—precisely the maneuver which the aviator strives to make under like circumstances. The following is an explanation of this interesting result, which will be made clear by an inspection of Fig. 5. Two components must be taken into account: First, the drift due to head-resistance and skin-friction, represented by arrow 1, in the figure; secondly, the lift due to reaction, shown by arrow 2. This latter is much more important, and since gyroscopic action resulting from the application of 1 would tend merely to reduce 2, and since the latter is of necessity always the greater, the combination of the gyroscopic force of 1 and the original force of 2 may be taken as one. Simplified in this manner, it may be easily ascertained that the machine will move as indicated.

Thus have all the ordinary movements produced either by voluntary control or by the action of extraneous forces been accounted for, and it is seen that in no single instance has the gyroscopic force generated by the motor operated deleteriously, but that, quite contrarily, it has in each case proven beneficial. It must not be inferred from the foregoing that all the actions described would force the machine to take the positions, or execute the movements, shown, but that there would be a distinct tendency so to move the machine, depending upon the suddenness with which the primary force was applied. The particular value of such an arrangement, from the point of view of stability, is that should these forces reach any considerable magnitude, they could lead to none other than a desirable result.

Considering now only practical advantages such as will appeal to the designer and the engineer, it will be found that there are many desirable features of the kind to recommend a mounting such as that described. Probably the first question that would present itself to the reader is that of providing a secure and rigid foundation. As now mounted the revolving motor requires a very awkward framework, extending entirely about the cylinders and culminating in a clumsy and heavy casting which carries the front bearing. A much lighter, simpler, firmer and altogether more workmanlike mounting is secured by placing the engine directly between the main longitudinal frame-members, a position which, besides adding greatly to the convenience of installation, permits of bringing the front ends of the framework together, securing added solidity not only to the motor but to the fuselage as well. This is made possible in the above construction by reason of the greatly reduced distance between
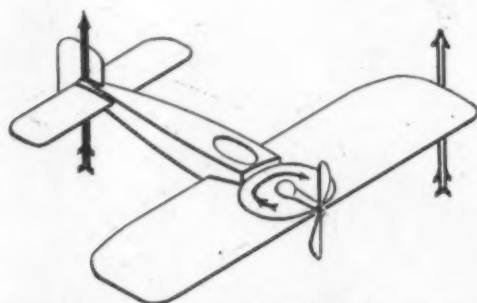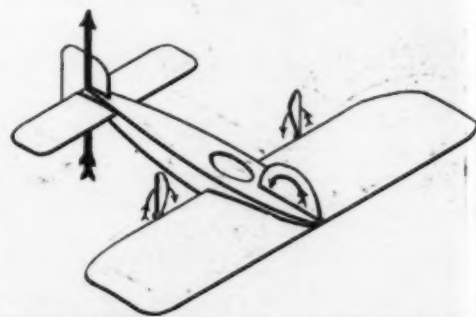

Fig. 3.—Descending: No gyroscopic stresses generated.

the frame-members, because when turned as suggested the narrowest part of the motor lies athwart the frame. Opportunity would be thus offered of ensconcing the aviator in a well of the same depth as formerly, but of greatly reduced width, in no manner inconvenient to him because the present width of machines is greatly in excess of one individual's requirements, and if it were necessary to provide a place for a passenger (as in war machines in which an observer is required), this would be accomplished by placing the seats in tandem.

Another point of considerable importance is the decreased head-resistance of the machine resulting

both from the lesser projected area of the motor (since it is placed edgewise to the wind) and also from the opportunity thus secured of giving finer lines to the body and more nearly approximating the stream-line form. Because of constructional difficulties inherent in a machine with the motor broadside-on the modern aeroplane body is very blunt, and though the evils accruing to such a form have been somewhat mitigated of late, notably in Deperdussin's "monocoque," we find that this has been accomplished only by completely inclosing the motor, and prolonging the fuselage some distance to the front, so as to obtain a conical nose-piece. It would be interesting to see what results might be obtained by taking advantage of the opening to more refined lines consequent upon the use of a much narrower hull, as suggested above.

The one objection that "practical" men might urge against placing the motor in the position that I have advocated is the necessity of driving propellers through transmission mechanisms instead of mounting them, as is now the practice, on the same shaft with the motor. It must be acknowledged that the direct-connected propeller has many good features to recommend it, but the fact that inventors have been willing of late to abandon these in securing advantages which are gained even at the sacrifice of being compelled to effect drives through bevel gears
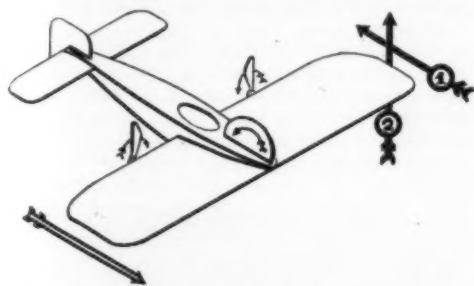

Fig. 5.—A wind-gust: The machine turns into the teeth of the wind.

or chains, and are favoring the latter construction in spite of its greater complication, proves that such increase in efficiency is to be gained by so doing that the measure is justified. Designers of aerial screws have found themselves confronted by much the same dilemma as that encountered by marine engineers during the time of the introduction of the steam turbine. They have discovered that the speed of greatest efficiency of the propeller does not correspond with that of the engine, with the conse-

quence that a compromise must be arrived at, much to the detriment of efficiency. It would appear that the same method will be ultimately adopted to cope with the difficulty as that introduced into
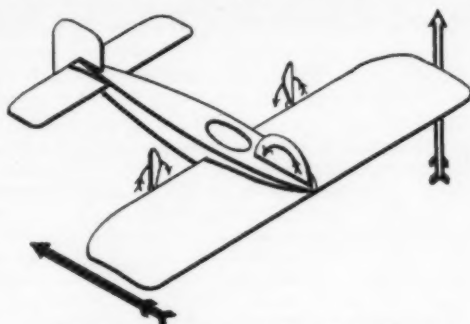

Fig. 4.—A right-turn: automatic banking

marine circles by Mr. Westinghouse, and it is worthy of remark that the early investigators—Mr. Maxim in England and both Prof. Langley and the Wrights of our own country—saw the advantages of such constructions and applied them to their own machines. The remarkable efficiency obtained in marine installations gives rise to the hope that the same method will prove as effectual when applied to aerial helices, and the fact that speed changing is being seriously considered, and is advocated even by such an authority as Dr. Bell, would throw additional weight on any arguments which might be made in favor of the adoption of gears.

This article would not be complete without a few words in regard to the actual method of carrying out these suggestions in the construction of a machine. Chain connection of the motor to the drive shaft, and thence by spur gears to the propellers would seem to be the most logical method of transmission, as it would permit two reductions in the gear-ratio while the engine could be given a position below the line of drive, thus lowering the center of gravity to any extent that might be desired, the shafting and gear-housings being concealed within the wings. Any difficulties arising from flexure of the shaft could be met by providing a simple universal joint at its middle section, and if a transmission were used, this would govern the smaller sprocket next the engine, as the higher speed there obtaining would mean decreased weight of the gear-wheels. There are many other methods of transmission, and racing machines employing two motors might find it advantageous to omit the chain and drive the propellers through gears alone.

Centrifugal force would not be wholly relied upon to secure ventilation of the motor, this being accomplished by inducing a current of air through the compartment in which it is placed after the manner of the familiar venturi tube. No difficulties would be met with in providing sufficient volume of air to secure adequate cooling, for when it is remembered that some recent racing machines having fourteen-cylinder engines have been almost completely inclosed, with provision for the escape of air only through small perforations located in the surrounding casing, and when we bear in mind that the seven rear cylinders in such machines are partly shielded by those in front of them and receive air already warmed by the latter, it is seen that no discomfiture need be apprehended on this score. And right here might be indicated yet another practical advantage—seemingly a small one to the layman but appreciated, assuredly, by the aviator—in the manner in which it is possible to dispose of the exhaust and the large amount of noxious lubricating oil which comes from the interior of the cylinders and is thrown off from revolving motors with the exhaust, in consequence of centrifugal force. This could be accomplished by so locating the position of the permanently
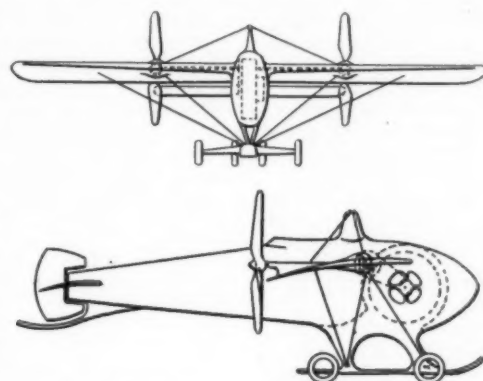

Fig. 6.—The author's conception of a machine, in which gyroscopic force would increase stability.

fixed crank-shaft, the cams governing the valves, and the point of ignition, that the exhaust would occur as the cylinder is nearing the lowest point in its travel round the shaft, so that all fumes would be taken away beneath the machine.

Fig. 6 gives the probable appearance of a monoplane having all the features which I have described incorporated in its construction.

The Passivity of Metals*

A GROUP of eight papers brought together with the view of setting forth every aspect of "passivity" as it presents itself to those now actively engaged in working out a satisfactory explanation of this most difficult and elusive subject, was discussed at a recent meeting of the Faraday Society.

The theoretical importance of passivity lies in the fact that it is in all probability so closely bound up with the fundamental mechanism of electrolytic action that a proper understanding of its cause will go far toward clearing away many of the difficulties which still surround the simple processes of anodic solution and cathodic deposition. It has further an important practical bearing on corrosion, for if this be an electrolytic action, a non-corrodible metal and a passive metal are, anyhow within certain limits, synonymous terms. The very idea of the connection suggests a line of research on non-corrodible alloys that may lead to most fruitful results. But if the subject is important, it is no less perplexing. At present two theories, in many respects diametrically opposed to one another, would appear to hold the field, one of which, broadly speaking, ascribes passivity to the presence of oxygen in some form or another, and the other to hydrogen. It may be added that the advocates of each theory point to an *experimentum crucis* claimed to prove the impossibility of its rival as a satisfactory explanation of all the phenomena which have been observed.

While attention was concentrated on the original observation made in 1790 by Keir, that iron became "passive" or indissoluble after plunging into strong nitric acid, the simple mechanical explanation that the change of state was due to a close film of protective oxide no doubt seemed all-sufficient. It was only when passivity was studied as an electrolytic phenomenon, as an example of anodic polarization by which the passive metal rises higher in the electro-

* Reproduced from *Nature*.

lytic scale toward the "noble" metals than it was in its active state, that a broader interpretation was called for, and hence was put forward Le Blanc's fruitful conception that the retarded anodic action was chemical and not mechanical in its origin, and that it must be explained as arising from the diminished reaction-velocity of some chemical process taking place at the anode. This conception is now universally adopted in the consideration of passivity phenomena; the only question arising is, What is the reaction the velocity of which is diminished when metals become passive?

To this question the following answers were given in the papers presented for discussion.

(1) Adopting the current view of Nernst that electrode potential is a result of the formation of metallic ions when the electrode is placed into an electrolyte, Dr. G. Grube supposes this action to be retarded under conditions known as passive by the formation of an alloy of anode surface and oxygen, which has a lower solution pressure than the pure metal. Such retardation of anodic action is known to take place when a platinum anode is used in the electrolysis of halogen salts, and for the self-same reason, and analogous cathodic retardation was likewise shown to exist by Dr. Grube; for example, when zinc and hydrogen are deposited simultaneously with iron. Much the same theory was developed by Dr. D. Reichinstein direct from the Nernst formula, and experimental support was given to the theory by Dr. H. S. Allen, who showed that the photo-electric behavior of iron, its property of losing negative electricity under the action of light, which from considerations of "fatigue" is believed also to be due to the state of the gaseous film on the metal, increases or diminishes in intensity according as the iron is in the active or passive state.

(2) In order to take into consideration the specific properties of the electrolyte anion some investigators are now reverting to the old Grotthus view of electrolysis that the primary action at the anode is not the formation of metallic ions, but a discharge of negative

ions (anions). Prof. Leblanc, however, further supposes that the anion is hydrated, and that passivity is merely the retardation of the reversible reaction, $\text{ion} - \text{hydrate} \rightleftarrows \text{ion} + \text{water}$. Prof. E. Schoch also adopts the theory of primary anion discharge, but impressed by Dr. Günther Schulze's experiments on the structure of aluminium anode-films, he considers that under certain conditions of current density, temperature, etc., there will be a diminished rate of reaction between anions and electrode owing to the formation on the latter of a film of oxide or oxygen. Neither of these theories, which seem to make gratuitous and unnecessary assumptions, were received with much favor.

(3) More attractive is the hydrogen theory stated in the paper presented by Prof. G. Schmidt, and supported by some ingenious and striking experiments. This supposes that the passive condition is normal, and that metals like iron and chromium are only rendered active by the diffusion through them of hydrogen, which acts as a catalyst and sets up local action. Possibly this is often the case, but it is doubtful whether the "hydrogen-activation" theory will explain all cases of passivity. In the end it may be found, as Dr. G. Senter said in the course of the discussion, that no one theory will cover every case of passivity, but the sense of the meeting was certainly in favor of either an oxygen-film or an oxygen surface alloy as offering in most cases a satisfactory working hypothesis of the passive state.

New Gold Fields in Siberia.—Persons who look upon the increase in gold production as responsible for the increased cost of living will regret to hear that important new deposits of gold have been found in Siberia (already one of the leading gold-producing regions of the world), viz., in the Transbaikal, Meshutochnaya and Bezvodnaya districts. A consular report states that these will rank among the richest fields in Siberia.

Reblading a Parsons Steam Turbine*

Tools, Devices and Methods Employed in Replacing Blades of a Turbine Rotor

By N. I. Mosher

In a machine shop where the writer was a foreman, a Parsons steam turbine from one of the United States Navy destroyers came in to be rebladed. After dismantling the unit the first step was to test the cases and rotor, to determine if they had taken any permanent "set" or distortion from the heat. A careful test showed the cases to be perfectly accurate, but it was found that the rotor had taken a permanent set that threw it 0.030 inch off center. This figure refers to the error that existed at the middle of the rotor, the error gradually diminishing until it was *nil* at each end. After careful consideration it was decided not to attempt to remedy this error until after the new blades had been set in the rotor. This line of action was adopted, because it was felt that further distortion would be sure to result from calking the blades in the grooves in the rotor. The method by which the error was finally eliminated will be described in a subsequent paragraph.

The next operation was to remove the old blades from the rotor and cases. In order to facilitate matters the rotor was mounted in a cradle of the form illustrated in Fig. 2, and the blades were removed with a hand chisel. A similar method of procedure was adopted in removing the blades from the turbine cases. An idea of the magnitude of this task may be gathered from the fact that the total number of blades was in the neighborhood of 60,000.

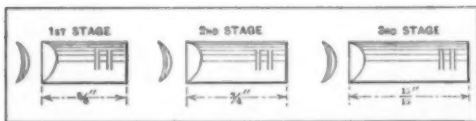The first step in preparing to reblade the rotor and

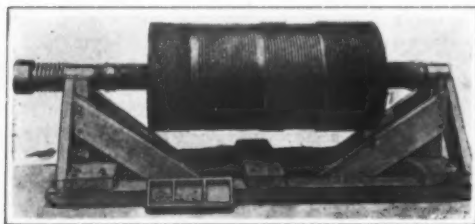Fig. 1.—Results of successive operations in forming the turbine blades.

Fig. 2.—Cradle in which the rotor was supported to remove the old blades.
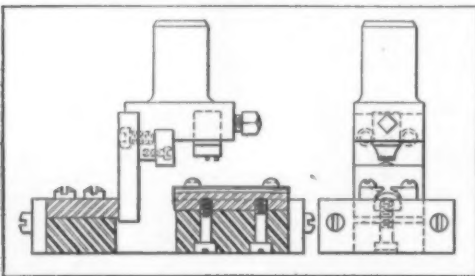

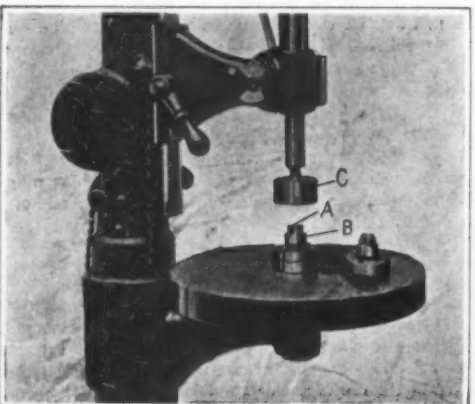Fig. 3.—Shear, punch and die used for cutting off and forming the new blades.

Fig. 4.—Method used for milling the end of the new turbine blades.

cases was to cut the blades and calking strips from the bar stock. This stock was purchased in lengths of 10 feet, and of the required form for the blades and calking strips. In preparing the blades the operations performed on the stock were as follows: First, pieces of the required length were cut off from the bar. Second, notches were stamped in one end of these blanks to provide for securing them in place in the turbine rotor and cases. Third, the opposite ends of the blades were then milled to the required form. The first and second operations were performed by the combination shear and die illustrated in Fig. 3. This die was used in a No. 18 Bliss power press operated at 90 revolutions per minute. At this speed 3,600 blades could be cut off and grooved in an hour, and the total time required to perform these two operations on 60,000 blades was 18 hours. This does not include the time occupied in adjusting the die.

The ends of the blades were next milled to the required form by means of an end mill mounted in the drill press shown in Fig. 4. The work holder consisted of a pin A, 5/8 inch in diameter, around which five blades were held by means of a collar B. The hollow mill C was fed down over the ends of the blades, and about ten seconds was required to complete the operation. The blades were quickly removed from the holder by simply turning it upside down. Two work holders were employed and two boys were engaged upon this work. One boy operated the machine and the other removed the finished blades from the holder and filled it with fresh blanks, while the milling operation was being performed on work held in the other holder. By this method, it was possible to mill about 900 blades per hour, and as long as the milling cutter was kept sharp, a perfectly smooth surface was produced. After washing these blades with gasoline, they were ready to be calked into the cases and rotor of the turbine.

The next operation consisted of cutting up the calking strips into pieces of the proper length. This material, like the stock from which the turbine blades were made, was purchased in 10 foot lengths and cut up by means of gang saws secured on the arbor of a Fox hand milling machine illustrated in Fig. 9. The saws were spaced on the arbor to cut off pieces of the required length and a stop was provided at the end of the fixture to enable the bar stock to be properly located in relation to the saw blades. By this means, six pieces were cut off at once and about 2,400 pieces could be cut per hour.

With the blades and calking strips prepared, the work of installing the blades in the turbine was started. In order to make a start in filling a groove, two wedges A and B were driven into place as shown in Fig. 5. One end of the wedge A is formed to the required angle and shaped to enable the first blade to be properly located against it. A calking strip C is next placed in the groove and calked sidewise to secure it in small grooves cut in the sides of the grooves in which the blades are mounted. These small grooves may be seen in Fig. 6. Alternate blades and calking strips were then put in place and calked until the opposite side of the
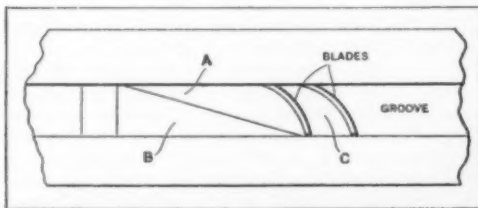

Fig. 5.—View of a groove in the turbine rotor, showing method of starting to replace the blades.

Fig. 6.—Model of section of rotor groove, showing blades, calking strips and wedges in place.

starting wedges was reached. The wedges were then removed and the remaining blades and calking strips put into place. A certain amount of manipulation was necessary to get the last few blades in, but after a little experience this part of the work was easily performed; and with one man putting the blades in place and the other calking them, it was possible to set 500 blades per hour. After a groove had been filled in this way, it was necessary to go back over the same blades a second time and set the calking strips endwise to expand them into the small notches that were stamped in the blades in a preceding operation. A third man performed this work and was able to proceed with about the same rapidity as the two men who set the blades in place. Fig. 8 shows the tools used for calking. The tool shown at A was used for expanding the calking strips sidewise and a tool of the form B was used for setting the strips endwise. It will be seen that there is a small hole in the end of the calking tool B. This leaves a mark on the calking strip and shows at a glance whether the strip has been set. The blades were mounted in the grooves in the cases in the same manner, but owing to the awkwardness of the position much more time was required for this part of the work.

After both the rotor and cases had been rebladed, the next operation was to true up the rotor and turn the blades down to a length that would give the desired
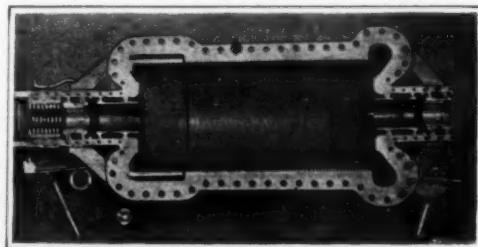

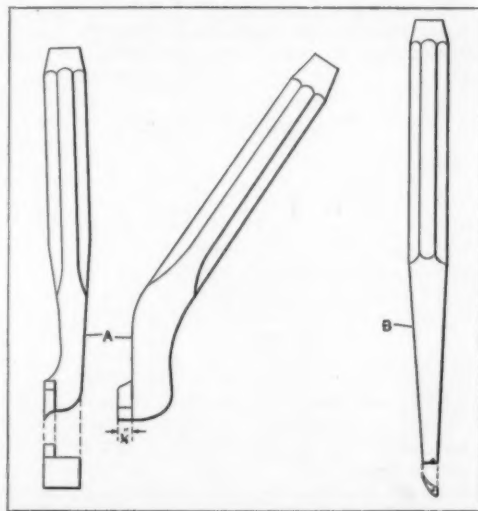Fig. 7.—Upper half of the turbine case ready to be bolted in place for boring the blades.

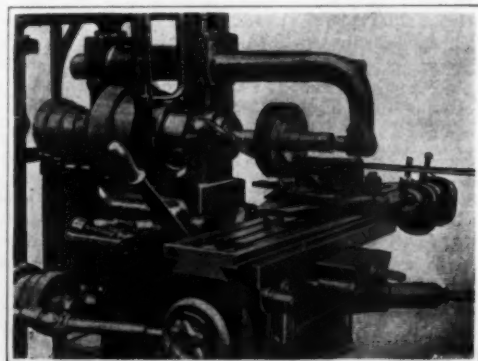Fig. 8.—Tools used for expanding the calking strips sidewise and endwise.

Fig. 9.—Milling machine fixture used for cutting off calking strips.

clearance. The blades were turned in a lathe provided with a special tool which cut the ends off clean without leaving any burr. The journals were next ground, and it was then necessary to balance the rotor. For this purpose the rotor was set up in a lathe and trued between the blades, i. e., the part that revolved close to the fixed blades in the cases. Truing up the drum in this way left one side 0.030 inch thicker than the other side—according to previous measurements—and this naturally threw the rotor out of balance. To correct this error, the rotor was mounted on hardened steel knife-edges and allowed to roll until the thick part of the metal—the heavy side—reached the lowest point. The necessary amount of putty to exactly balance the rotor was then placed on the thin side of the drum. The weight of this putty was then determined and its weight in steel secured to the light side of the drum by means of screws. Thus an accurate balance was secured.

The blades in the cases were finished to the required length in practically the same way that the cylinders of a reciprocating engine are bored. Fig. 10 shows the lower half of the case set up on a surface plate with a 6-inch boring bar fitted in the bearings and driven by an electric motor and belt. A special tool was fitted in the cutter head, the tool being set to about 0.010 inch smaller radius than the cases should have when finished. The upper half of the case, shown in Fig. 7, was then lowered into place and securely bolted. In this way, the cases were in exactly the same condition as they would be if the turbine were in operation. After running the first cut through, the cutter head was drawn back to the starting point and a second cut was then taken with the boring bar expanded 0.010 inch, which machined the blades down to exactly the required length. The adjustment of the tool and the calipering of the bore was accomplished by reaching through the exhaust nozzle. The time required to bore the rotor cases was 8 hours. About the same length of time was required to turn the blades in the rotor to the required length. A clearance of about 0.030 inch was left between the cases and the blades of the rotor. After the cases had been bored out, the bar was removed and the chips and dirt blown out. The bearings were then adjusted, after which the rotor was lowered into place and the cases bolted together.
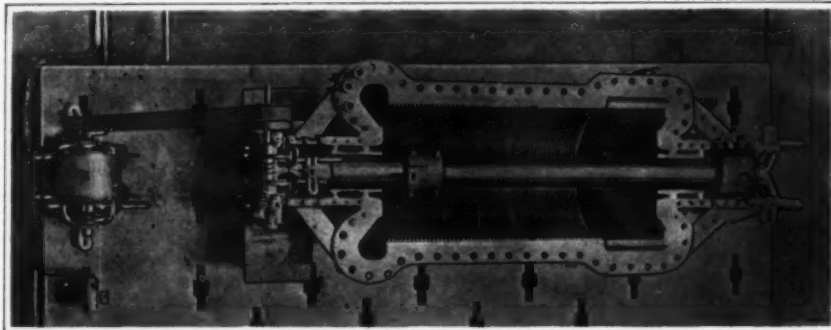

Fig. 10.—Arrangement of the boring-bar for machining the ends of the blades in the cases.

Winter Troubles on Electric Railways*
By Charles J. Jones

THE operation of electric railways in sections of the country where there is little or no snowfall, differs but little from the regular performance at other seasons. Where the winter is a rainy season of a few months the problem becomes one of railway construction, requiring waterways of sufficient number and capacity and properly located so as to avoid breaks in the roadbed due to washouts. In our northern districts, where the snowfall is of some importance, the question of maintaining the schedule in winter becomes at times a difficult one and a source of anxiety. Snow, sleet, ice and frost are the trouble makers, and the manager who contends successfully against them is the one who has made full preparation before the winter had made its appearance.

The maintenance-of-way department should see to its waterways and bridges. Where pile bridges are maintained over streams, such tools and explosives as may be necessary to protect the supports from ice should be on hand and ready for use. Heaving of track by frost is a menace to the safe operation of trains, and is a frequent cause of delay to the service. It seems almost impossible to obviate this trouble entirely, but as it is usually the result of poor drainage, it is important that all ditches in the cuts should be cleaned before the frost comes. Certain cuts cannot be drained properly by the ordinary ditch, and it then becomes necessary to lay drain tile a few feet below the ditch in order to draw away the moisture from the subsoil.

Sleet and ice coupled with high winds are serious factors to be considered in the proper maintenance of transmission lines and the assurance of a continuous supply of power. Poles and cross-arms should be carefully inspected and strengthened where necessary; new insulators should replace doubtful ones, and all wires (telephone, trolley and transmission) should be looked over and the weak places made strong. On lines where the third-rail takes the place of the trolley wire, the same careful inspection should be made and proper attention given to the insulators, underground cables (with the necessary drainage thereof) and the cable terminals. The loss of power for a short time during the progress of a winter storm may mean the loss of train service for many hours.

SNOW FENCES AND SNOW PLOWS.

The handling of snow may be considered under two heads: 1. Methods of preventing snow from accumulating. 2. Methods of removing snow.

Methods of the first class as applied to interurban lines include the widening of cuts and the use of snow fences. Where trouble from snow drifts occurs annually, a permanent board fence may be erected in place of the usual right-of-way wire fence. Frequently we use boards nailed to the regular fence, supporting them by nailing to the fence wire and to an intermediate post. Portable snow fences may be set out in the fall and removed in the spring. These are usually made in panels about 16 feet long and 6 feet high, and should be set from 50 to 100 feet from the track.

As a rule, landowners do not object to allowing these fences on their land, but in some cases compensation is demanded. A wise forethought while securing right-of-way has in some instances provided for the right to use portable snow fences on the adjoining property,

and where possible this should always be done. These fences cost about 25 cents per linear foot, and when properly placed are extremely valuable in preventing the snow from drifting into the cuts. As the snow piles up around them, these fences can be raised on the drifts or set farther back as occasion warrants.

There seems to be no reason why the usual wire right-of-way fence should not be replaced in places subject to snow drifts by hedges of osage orange, honey locust, Japan privet, tartarian honeysuckle, or other hardy growth, which could be kept trimmed to fence height. In addition to acting as a partial protection against drifting snow they would make a permanent right-of-way fence, neat in appearance and effective in preventing cattle from passing through.

Methods of the second class, referred to as the "removal of snow," are various. They include many devices, from the man with the shovel to the light rail scraper and the powerful mechanical plow. The man with the shovel is not to be disregarded, as he is an essential factor in any snow-fighting equipment. His limitations, however, are apparent to anyone who has attempted to clean snow from a track with a hundred and more men in the face of a gale of wind, the air dense with drifting snow and the temperature about zero. He no doubt has felt not only the effect of exposure to the storm, but also that of discouragement when, upon looking back, he has found that the section just cleared from snow was again full.

On city lines it is usual to equip the cars with scrapers, which are under the control of the motorman and so arranged that the blades are held on the rail under pressure. On all unpaved streets and highways it is important that the mud and dirt should be scraped aside and leveled down to the rail before it becomes frozen. If this is not done, the scraper will not be able to reach the rail and the motor and gear casings will be dragging on the high places.

The rotary broom sweeper is used especially on city lines and, being very effective, should be included in the snow-fighting equipment of all companies operating cars on streets and highways. These sweepers may also be equipped with wings which push the snow beyond the range of the brooms. As the sweeper throws a cloud of snow it is important that it should be operated by men of good judgment, as the flying snow is very likely to frighten horses. The electrical equipment to operate these sweepers varies according to the ideas of the purchaser, but the mistake of having slow-speed motors to drive the brooms should be avoided.

On lines operating on private right-of-way in the open country the high V-shaped nose plow and center-share plow prove to be highly efficient. These plows also are equipped with adjustable side wings to push the snow farther aside. These types of plows practically force their way through the snow and the secret of their success is weight of car and high speed. They should have the speed of the fastest passenger car on the system, in order to be able to run ahead of the regular cars and keep clear of them, and also for the purpose of clearing a larger track mileage. The writer has passed through snow drifts varying from 2 to 10 feet deep and 2,000 feet long with a snow plow of the center-nose type built on a flat car 34 feet long (50 feet over points of plows), with wings open to clear a width of 11 feet. It was weighted down with rails and old iron; equipped with four 125 horse-power motors, and geared to a speed of 72 miles per hour.

Passenger, freight and express cars are frequently

equipped temporarily with a small nose-plow attachment, and are able to cut their way through snow that otherwise would stop them. In sections where the snow conditions are severe, the rotary snow plow is much to be desired. This type of plow has a large pan or hood in front, with spreading wings to collect the snow as the car is driven forward. Within the hood is a revolving wheel fitted with blades which cut the snow and carry it upward, throwing it a considerable distance to the side.

The movement of cars through snow soon forms a crust which becomes harder as the motor casings continue to drag on it. This hard center not only checks the speed of the cars, but causes a loss of power in proportion to the extent to which the casings ride on it. This condition becomes at once apparent if a car having smaller wheels than the others is run over the line. When such a car comes to the hard centers it soon stops, and efforts to move it bring only spinning wheels. Upon examination it is found that the motor casings are riding on the crust of snow and raising the wheels from the rails, destroy the traction effort. To remove this hard center we have the scraper and flanger, which is usually lowered and raised by compressed air. In some cases a device with steel points arranged in the form of a tooth harrow is used successfully to break down the hard center. In congested terminals and streets where the snow can no longer be pushed aside by the wings of snow plows, etc., it becomes necessary to load it on wagons or cars and haul it to the most convenient place for unloading.

ORGANIZATION FOR FIGHTING SNOW.

Snow storms vary in intensity and in kind, and it is hardly possible to depend upon a single type of snow plow or sweeper to overcome them all. Certain types of plows are better adapted to control certain storms. To have at command any or all of the above-mentioned snow-fighting devices is not alone sufficient; there must be organization for the work. The organization should be carefully planned in advance and the men included therein fully instructed and trained, so as to avoid confusion or misunderstanding when the emergency arises. Men trained to a particular work of this kind should be kept there, if possible, as experience is a valuable asset. The men should be instructed to report for duty immediately upon the first snowfall and be ready to take charge of the work allotted to them. The superintendent or officer in charge should be where reports of progress or difficulty can reach him promptly, so that he can act in accordance therewith with precision. The work must be started with the appearance of the storm, without waiting until reports come in of the cars being stopped.

Having an organization and equipment, it is also important that the equipment be thoroughly overhauled and put in condition for immediate service at the beginning of winter. When the threatened danger has made its appearance, there is no time for repairs or the purchase of shovels and brooms or plows. A contest against the storms of winter is war, so let us follow the adage, "In time of peace, prepare for war."

Theodore William Richards, Irving Professor of Chemistry of Harvard University, has been elected president of the American Chemical Society for 1914. Prof. Richards graduated from Harvard with the class of 1886, and, with the exception of several trips to Germany for purposes of research, he has been entirely engaged in teaching at Harvard.

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The Sudden Origin of New Types—III[*]

By Felix Oswald, D.Sc., B.A., F.G.S.

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THE rise of the GASTROPODA, and still more of the highly organized CEPHALOPODA, must have been correlated with the acquisition of a jaw-ribbon or radula, which is such a typical characteristic of these classes that they are classed together as Glossophora. This structure forms an immense advance on the presumably Annelidan jaws (conodonts), which are known from the Cambrian. But, unlike the conodonts, the radula has never been definitely recognized in fossil form, hence its evolution cannot be tested by palæontological methods. However, it has been conclusively shown by Martin F. Woodward that the radula of Pleurotomaria represents the most archaic type among existing Gastropoda; and this genus is known to have persisted from the Upper Cambrian. Woodward comes to the conclusion that its radula, in which as many as three tracts on either side of the median are distinguishable, was derived from one in which all the teeth in a transverse row were similar.

An early reduction must have taken place to reach the optimum of three tracts on either side. Even in the case of Pleurotomaria the five tracts are not equally distinctly differentiated from each other, so that at a superficial glance only three tracts would be distinguished on each side of the median one. From this primitive Rhipidoglossate type all the remaining types can be derived by fusion and reduction. It will be sufficient here to indicate very briefly some of the main lines along which reduction has taken place. In the Rhipidoglossate Trochus only two lateral tracts are clearly distinguishable: x. 5. 1. 5. x. In the Docoglossate radula of Patella we find the series 3. 1. 2. 0. 2. 1. 3. in which it is assumed that the median tooth is either altogether aborted or sometimes reduced to a rudimentary plate. In the Tænioglossate Cypræa all the teeth of each of the three tracts have been fused into one large tooth so as to give the formula 3. 1. 3. In the Rachiglossate Nassa fusion has reached the still further extreme of 1. 1. 1. Finally, the central tooth may be absent, as in the Toxoglossate Conus with the formula 1. 0. 1, or as in the Ptenoglossate Janthina and Scalaria with x. o. x.

In spite of the high degree of specialization in different directions which is so characteristic of Crustaceans at the present day, we find on closer examination that among the various classes there are still in existence some remarkably persistent and even generalized types. One of the most striking instances of such persistence is furnished by the discovery in 1893[25] of the Tasmanian Mountain-shrimp (Anaspides tasmaniæ, G. M. Thomson), for which a new division—the SYNCARIDA—has had to be created, equivalent in importance to the PHYLLOCARIDA containing the equally archaic form Nebalia. Anaspides can indeed hardly be distinguished from the Carboniferous Prœanaspides discovered by Dr. Moysey[27] in the Coal Measures of the Nottingham coalfield in 1907.

Nebalia similarly represents a remarkable persistence of an extremely ancient and generalized type, with which Hymenocaris of the Cambrian, and the Ordovician Ceratiocaris[28] and Caryocaris are combined to form the separate class of the PHYLLOCARIDA or LEPTOSTRACA, intermediate between the ENTOMOSTRACA and the MALACOSTRACA. The even more generalized Apus is known from the Trias and seems to have been represented by the very similar Protocaris of the Lower Cambrian of North America. In point of fact, in the face of all these long survivals from the Palæozoic era down to the present day, it becomes really a matter for surprise that such successful classes as Trilobites and Eurypterids should have died out altogether when all the other and apparently more specialized classes of Crustaceans and Arachnids of Palæozoic times should have left descendants existing at the present day. Several zoologists have indeed within recent years treated the Trilobites as a generalized central group, from which not only Insects and Myriapods but even Pycnogonids (not yet known in a fossil state) have arisen in divergent directions.

On the assumption of the descent of Insects from a Trilobitan offshoot which had taken to a fresh-water habit, it is at any rate noteworthy that, according to the theory of this paper the class of Trilobites can be held to comprise all the necessary characters which have already been seen to be preliminary to the origin of a new group: in particular the body-segments are extremely numerous and vary greatly in number. This circumstance is, of course, sufficient to.initiate a great amount of variability. It is also a significant fact that the last marine survivors of the class occurring in the Carboniferous and Permian belong to the order Proëtidæ, which comprises trilobites with the largest number of thoracic segments, viz., up to 22. It is true that so large a number is not reached in the latest (Permian) forms, viz., Phillipsia (9) or in Proëtus (8-10), which ranges from the Ordovician to the Permian of the United States—an unparalleled length of range for a Trilobite—but the Proëtidæ were evidently a somewhat generalized type of Trilobite, and it is only from a generalized stock that a new class can be evolved.[29]

It does not seem to be outside the range of probability that the severe desert-conditions of the Old Red Sandstone period, with its evaporating lagoons and shrinking rivers, may have been the means of causing in the (hypothetical) fresh-water branch of the Trilobites the evolution of greatly extended pleuræ, first of all for the purpose of offering a greater respiratory area in waters steadily becoming poorer in oxygen. For
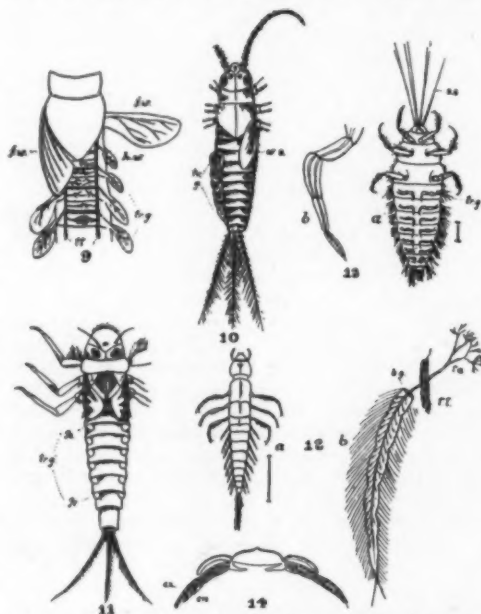

FIG. 9.—Chloëon dimidiatum. Thorax and interior segments. f.w., forewing; h.w., hindwing; tr.g., tracheal gills; t.t., tracheal longitudinal trunks. FIG. 10.—Chloëon dipterum. Nymph, ♂; wing-sheath of left side and gills of right side removed. w.s., wing-sheath; tr.g., tracheal gills. FIG. 11.—Oligoneuria garumnica. Nymph. ♂; tr.g., dorsal tracheal gills. FIG. 12.—Sialis lustaria. a, larva; b, tracheal gill; b.g., base of gill; t.t., tracheal trunk into which gill is connected; t.a., trachea given off to alimentary canal. FIG. 13.—Sisyra fuscata. a, larva, ventral aspect; b, abdominal appendage (gill); s.s., sucking spears; tr.g., tracheal gill. FIG. 14.—Triarthrus becki. Section through second thoracic segment. ex, exopodite; en, endopodite.

this theory it is necessary to assume that the Trilobitan ancestors of the insects and myriapods had abandoned the habit of secreting lime[30] in the exoskeleton (which would thus become purely chitinous) concomitantly with their migration from the sea into fresh water. The very fact of a creature with a calcareous exoskeleton taking to a fresh-water existence necessarily implies the diminution or total abandonment of the calcareous portion, owing to the solvent action of the relatively large amount of carbon-dioxide in river-water. The massive, stony carapace of most lobsters and crabs is not to be found among their fresh-water relatives such as the crayfish or the river-crab (Thelphusa). In the latter forms the carapace, though still in part calcareous, is so thin that it can be cut with a pair of scissors. The erosion of the umbos or apices of fresh-water molluscs, where the protecting epidermis has been

worn away, is a familiar instance of the destructive power of carbon-dioxide on calcareous shells. According to Semper[31] the epidermis becomes destroyed in the first place in these prominent parts of the shell by boring fungi aided by the wearing action of fresh-water currents.

As a matter of fact, the young states of Blattidæ (e.g. of the Australian Oniscosoma among living insects and of some of the Carboniferous insects, v. infra) show that the wings are actually nothing but lateral expansions of the segments exactly as the pleuræ of Trilobites are the lateral expansions of the body-segments. It is only necessary to presume that the pleuræ of the hypothetical fresh-water Trilobite became thin and membranous and traversed by tracheæ in order to obtain an exact counterpart of a tracheal gill.

It is a matter of considerable importance that no undoubted insect-remains are known previously to the Carboniferous epoch, for the Protocimex silurica of the Upper Ordovician of Sweden and the Palæoblattina Douvillei of the Silurian of Calvados are evidently merely inorganic structures. Furthermore, the Little River group of New Brunswick, which has yielded so many remains of insects and was formerly considered to be of Upper Devonian age, has now been clearly proved to be not older than the lower part and not higher than the middle part of the Upper Carboniferous. Hence we find that insects exemplify a sudden outburst of a group in the Carboniferous, immediately subsequent to the unusually rigorous desert-conditions of the Old Red Sandstone, which were equally instrumental in inducing the evolution of air-breathing amphibians from paddle-finned fishes, or the air-breathing Scorpions and Anthracomarti from their purely aquatic allies. The pools of stagnant water would eventually dry up altogether and only those individuals which could reach another sheet of water would survive to perpetuate their race. During the process of stagnation[32] and evaporation it is not difficult to imagine that those forms in which the tracheal gills were more extensively developed, and sufficiently stiffened to prevent collapse, might be able to leap out of the water, and if this happened it seems obvious that the moist membranes would be able to absorb oxygen from the air. Such invigorating leaps would gradually become extended into short flights (analogous to those of flying-fish), by means of which the tracheal membranes would become stouter and stronger, and the necessary muscles would soon become developed in correlation with this new function, while at the same time the original respiratory function of the tracheal gills would still be actively exercised.

This picture is by no means so fanciful as it might appear to be at first sight, for it affords a plausible explanation of a possible gradual change from tracheal gills to gliding-planes and so to true wings, without implying any break in continuity of function. The transition from tracheal gills to wings can even be observed at the present day in Ephemerid larvæ, such as that of. Chloëon, in which both the wings and the 6-7 pairs of tracheal gills entirely agree in their mode of origin; indeed some of the tracheal gills in this form are at one period of their development even larger than the hind wings (Fig. 9), and the branching of the veins in the wing corresponds very closely to the branching of the tracheæ within the tracheal gills. Of all modern insects the Ephemerids seem to stand nearest to the Carboniferous Palæodictyoptera, and are connected with them by a practically continuous palæontological succession of intermediate forms. Hence it is not unreasonable to presume that some of the modern forms would still possess some relics of archaic organization to throw light upon the process of the transition from gills to wings, which must have taken place in pre-Carboniferous times. Now as a class the Ephemerids contain more forms with tracheal gills than any other class of insects. At this stage, however, it is necessary to point out that some confusion has arisen from not recognizing that tracheal gills may have two distinct modes of origin, viz., (1) lamellar tracheal gills, as in Chloëon (Fig. 10), Oligoneuria (Fig. 11), Tricorythus (Fig. 15), etc., which are clearly modified pleuræ, and it is only from these structures that wings could be

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[*] Science progress.

[25] Thomson, Trans. Linn. Soc. (2), vi. 1894-7.

[27] Geol. Mag. 1908.

[28] The Carboniferous Ceratiocaris scorpioides and C. elongatus have been, however, considered by some to be CUMACEA, but this view seems hardly tenable.

[29] The Cambrian Paradoxidæ, which probably stand close to the ancestral stock, is the only other order of Trilobites in which the thoracic segments approach so large a figure, viz., 16-20. In the Cheiruridæ, which are nearly allied to the Proëtidæ, the thoracic segments vary from 9-18, and the pleuræ become partly separated from each other in Cheirurus and are totally separate in the phantom-like Deiphon; if these separated pleuræ became flattened and membranous they would almost foreshadow tracheal gills, which would (as discussed later) appear to be the forerunners of wings.

[30] It must be noted, however, that in the Myriapod DIPLOPODA (CHILOGNATHA) but not in other Myriapods the chitinous exoskeleton contains calcareous matter and is thus rendered much less flexible than in the other orders of MYRIAPODA.

[31] Natural Conditions of Existence, etc. London, 1881.

[32] It is interesting to find that stagnant water seems to exercise a marked influence in increasing the extent of variability; this has recently been established for Cyclops by Dr. Esther Byrne (Fresh-water Species of Cyclops of Long Island, Cold Spring Harbour Monographs No. VII. 1909). In this monograph, which is based on several years' work, the author finds that "variation of a varietal type is strongly developed, but much more so in some species than in others; it attains its maximum in the forms inhabiting stagnant waters, which can only exist at all by the power of readily adapting themselves to environment.".

derived; and (2) filamentous tracheal gills, which are modified abdominal limbs, as in Sialis (Fig. 12) and even more clearly in the Hemerobiid Sisyra (Fig. 13) inhabiting the cavities of the fresh-water sponge. Now if we consider a section through the Trilobite Triarthrus (Fig. 14), it can be seen that there is no inherent difficulty in deriving the lamellar gills of Ephemerids from the pleuræ of a Trilobitan ancestor, while the fringed and jointed tracheal gills of Sialis can be derived with but little change from the setose exopodite of the Trilobite, and the more leg-like appendages of Sisyra from the endopodite. In the nymph of Tricorythus (Fig. 15), a pair of filamentar gills are present at the same time with four pairs of lamellar gills, of which the anterior pair is greatly enlarged to act as a gill-cover to the three posterior pairs and is, furthermore, nearly equal in size to the immature wings.

It is unfortunate that the strata of the Old Red Sandstone are so ill-adapted for the preservation of delicate chitinous remains, as the Carboniferous insects already show a very considerable differentiation and reduction to an optimum, e.g., to three pairs of legs and to ten abdominal segments. Evidence is not wanting to show that the reduction had been of very recent occurrence, for the eleventh segment of the abdomen and the telson are not yet quite suppressed; the wings are equal in size and show similar neuration; a wing-like expansion with veins is present on the pre-thorax of several Protephemerid forms, e.g., Lithomantis carbonarius (Fig. 16), Stenodictya lobata, Homaloneurina Bonnieri, Homoioptera Woodwardi, Homæophlebia gigantea; gill-like pleuræ occur in each abdominal segment in Stenodictya lobata; and Corydaloides Scudderi possessed tracheal gills (containing distinct tracheæ) in the imago, similar to the tracheal gills of certain Ephemerid larvæ of the present day. In the imago of the living Perlid Pteronarcys tracheal gill-tufts actually persist (Fig. 17). It is also of interest to note that the larvæ of Perlidæ have rather large compound eyes, the ocelli being merely opaque spaces. The future wings are represented in these larvæ by lobe-like prolongations (varying in length according to age) of the meso- and meta-notum. Many of the Perlidæ also present the curious phenomenon of micropterism among the males, e.g., Tæniopteryx, Nemoura trifasciata, Perla maxima, Dictyopteryx microcephala, Isogenus nubecula. It is not impossible that these cases may be instances of reversion in a primitive group of insects (all with feeble powers of flight), which has progressed only slightly in comparison with the majority of insects from the ancestral Carboniferous stock.

In the Protephemerid division of the Palæodictyoptera the wings could not be folded back over the abdomen, but remained horizontal when at rest and were only capable of motion in one plane, a characteristic which has been retained by the modern Ephemera. Some Carboniferous larval forms clearly show a gradual development of the wings, standing out horizontally at right angles to the body.

Representatives of the heterogeneous group of Myriapods[33] occur at an earlier date than insects, for the Archidesmidæ (Kampecaris and Archidesmus) have been found in the Old Red Sandstone of Scotland. These forms, together with the numerous Carboniferous Euphoberiidæ (Fig. 18) and Archijulidæ are placed in a special order, the Archipolypoda, differing from the Diplopoda in the dorsal scutes being more or less divided into two parts instead of being fused into one but agreeing with them in there being two pairs of legs to each ring, which thus corresponds to a double segment (two fused segments). Probably the Diplopoda have been derived from this order by a process of reduction but the earliest known type of this order—Julopsis cretacea—occurs only in the Cretaceous of Greenland.

There are several points in which the Archipolypoda can be held to approach the Trilobites, from which some zoologists consider them to be derived: the fusiform body is thickest in the anterior half or third; the cephalic appendages are borne on an apparently single segment. Stigmata occur on each segment, so that they were presumably air-breathers; but Scudder considers that the lateral openings of Acantherpestes were branched in character, so that this type would help to bridge over the transition which must have occurred in the Devonian period between gills or gill-books and tracheæ.

In the Archipolypoda the pleuræ are well developed, and in the modern Polydesmus (Fig. 19), to which the Devonian Archidesmidæ show much resemblance, we can even yet trace a distinct trilobation of the body comparable with that of Trilobites. The single pair of antennæ also is a characteristic which the Myriapods possess in common with Insects and Trilobites, in abrupt contrast to all Crustaceans (with two pairs) or to Arachnids (with only cheliceræ). In the larva of Polydesmus the lateral cheeks of the head present a striking analogy to the free cheeks of Trilobites; here too there are only three pairs of legs on the three

[33] The Chilopoda, Symphyla and Diplopoda are now usually treated as independent classes.

anterior trunk-segments, presenting an interesting parallel to the permanent reduction to three pairs in insects. New segments gradually appear posteriorly and the number of legs increases, a state of things very analogous to the increase of vertebral segments in snakes or to the addition of the fifth pair of legs in some Pycnogons (Decolopoda and Pentanymphon), where it is a comparatively new development and not a primitive character; in fact the larval Pycnogon has only three pairs of appendages.

As a set-off to this increased number of similar segments, which is obviously a secondarily acquired characteristic (although it must have occurred early in the history of the group of Myriapods), the Symphyla show a marked reduction, possessing not more than twelve leg-bearing trunk-segments, with but one pair of legs to each segment and only a single pair of tracheæ respectively. The anal segment and the indication of a pre-anal segment would bring up the total number of segments to fourteen, which would closely correspond to the original thirteen or fourteen segments (thorax and abdomen) of insects. Probably the Symphyla stands nearer to the Insectan stock, from which the Thysanura branched off, than the other Myriapod classes and in several respects they show primitive characteristics. Possibly they are represented in the fossil state by Scudder's Protosyngnatha, which is constituted by the single Carboniferous form Palæocampa anthrax, with ten body-segments, from the Carboniferous of Illinois.
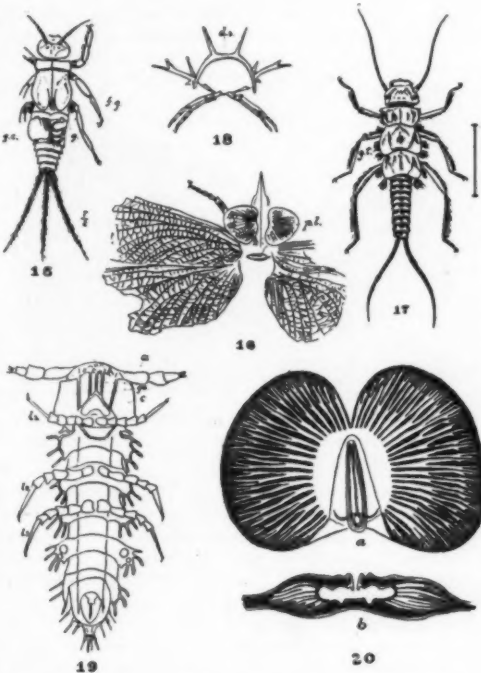

FIG. 15.—Tricorythus sp. Nymph, ⅔. Gill-cover (g.c.) of right side removed, showing gills (g.); f.g., filamentar gill. FIG. 16.—Lithomantis carbonarius, ⅔. p.l., prothoracic lobe. FIG. 17.—Perla sp. Nymph. g.t., tracheal gill. FIG. 18.—Euphoberia ferox, Salter, ⅓. Section of a segment. d.s., dorsal shield with spines. FIG. 19.—Polydesmus complanatus. Larva, just hatched. a, antenna; g.c., gnathochilarium; c, cheek; l₁, l₂, l₃, the three pairs of legs. FIG. 20.—Scutigera coleoptera. Tracheal mass of a dorsal plate. a, from above; b, transverse section.

The essential characteristic of all Myriapods and Insects is their segmental tracheal system, which must have already appeared in their common ancestor; although at first sight no two structures could seem to differ more widely than tracheæ and lung-books (like those of Scorpions and Spiders), yet it seems probable that the former are in reality derived from the latter. It is among the Myriapods that we can even now dimly see how this was brought about, especially by examining the tracheal system of Scutigera[34] (Fig. 20), among the Chilopoda, although in their case there is obviously much specialization. Here we find that each (unpaired and dorsal) stigma opens into an air-sac, from each side of which about 300 radial, branched tracheal tubes arise, closely packed together, forming a kind of lung. This arrangement is essentially similar to the tracheal lungs or book-leaf tracheæ of Arachnids, with the sole exception that in these the tracheæ are flattened out into lamellæ. Since ribbon-like tracheæ occur in Araneids, it is evident that book-leaf tracheæ could pass without any violent transition into ribbon-like tracheæ and finally into the typical tubular tracheæ, which are so eminently adapted for a purely terrestrial mode of life.

The multiple repetition of similar lamellæ would

[34] It is placed in a separate order, the Schizotarsia, by F. G. Sinclair, Camb. Nat. Hist., Myriapods, 1895.

again be conducive to inducing an extensive amount of structural variations, capable of leading onwards either to the tubular, branching tracheæ of Insects or to the tufted tracheæ of Pseudoscorpionida and many Araneida. It is obvious that tracheæ must have arisen independently in Insects, Arachnids[35] and Peripatus.[36] It is a particularly suggestive circumstance that in the dipneumonic Araneida tubular and book-leaf tracheæ occur simultaneously.

Since it has been shown by Brauer that the lung-books of Scorpions are derived from gills borne on mesosomatic appendages,[37] there is clearly no difficulty in assuming that the gills of the hypothetical fresh-water Trilobite could similarly have been transformed into lung-books sunk in the body and communicating with the air by stigmata; and once this step was accomplished the further transformation into tracheæ could follow as indicated in the foregoing paragraph. A very primitive condition of tracheæ exists in Campodea, in which three pairs of spiracles are situated in the thoracic region, and the tracheæ of each stigma keep distinct, so that there are six separate small tracheal systems, three on each side of the body. In Machilis also the nine pairs of tracheal systems keep distinct from each other.

Other instances of the application of this theory to explain the sudden development of new groups in the organic world might be readily multiplied; but the foregoing examples may perhaps be considered sufficiently striking to obviate the undue expansion of this paper by entering into further details at the present juncture.

The Production of Animal Heat

Since Rubner's fundamental experiments* in relation to the long-standing problem of the source of animal heat, the conclusions which he reached regarding the equivalence of the heat actually produced in the animal body and the amount computed from the catabolism have been verified by others. Most important among these corroboratory studies, which demonstrated that the law of the conservation of energy finds a strict application in the animal body as well as in the inanimate world about us, are the widely known researches of Atwater and Benedict,† which established beyond a reasonable doubt that in man as well as in the carnivora the same equivalences between chemical energy, heat energy and mechanical energy obtain as elsewhere.

Although there is no reason to believe that the fundamental nutritive processes in herbivora are essentially different from those which exist in the carnivora and omnivora, the character of their digestive processes, involving as they do quite distinct types of foods along with the pronounced participation of bacterial activities, has always made direct investigations on herbivorous animals, and particularly on ruminants, appear desirable. It must be borne in mind that this group of animals experiences extensive fermentation of carbohydrates, especially in the capacious first stomach, with the production of large amounts of carbon dioxid, methane and sometimes hydrogen. Furthermore, the urinary end-products are also distinctive, including, in addition to hippuric acid, notable quantities of ammonia and more or less organic matter of unknown nature.

For some years the desired experiments have been conducted at the Institute of Animal Nutrition of the Pennsylvania State College under the leadership of H. P. Armsby. Few who have not engaged in comparable experimental work can realize the numerous sources of error and appreciate the necessary precautions which such undertakings entail. It is gratifying to note, therefore, that a total of fifty-seven experiments conducted in the past ten years have verified the expected result. The differences between the calculated and observed heat production in twenty-four hours in the total of all these numerous trials is only 0.4 per cent—truly a close agreement.‡ The outcome is a credit to American science. It has an importance in its economic aspect as well as from a physiologic point of view. Agricultural animals are transformers of chemical energy, storing up portions of it in forms available for man's nutrition. The fundamental laws governing these transformations have now been firmly established.—Journal of the American Medical Association.

[35] In Araneids the main trunk of the trachea histologically resembles exactly the general chamber of the lung-sac and is quite different from the trachea of Insects.

[36] Peripatus can hardly be regarded any longer as a member of the ancestral stock of Myriapods and Insects, but as a highly specialized side-branch of the Annelidan ancestor of Arthropods.

[37] Dr. F. W. Purcell (Quart. Journ. Micr. Sci. liv. pt. 1, 1909), in a memoir on the development and origin of the respiratory organs in Araneæ finds that in spiders also the lung-books are derived from gill books similar to those of Limulus, for the first leaves of the lung-books appear on the free posterior side of the provisional abdominal appendages, quite outside of the pulmonary invaginations.

*Rubner, M.: Ztschr. f. Biol., 1894, xxx, 73.

†Atwater, W. O., and Benedict, F. G.: U. S. Dept. Agriculture, Office of Expt. Stations, Bulls. 109 and 136; Mem. Nat. Acad. Sc., viii, 1235. For herbivora see also Laulanie: Arch. de physiol. norm. et path., 1898, p. 748.

‡Armsby, H. P.: A Comparison of the Observed and Computed Heat Production of Cattle, Jour. Am. Chem. Soc., 1913, xxxv, 1794.

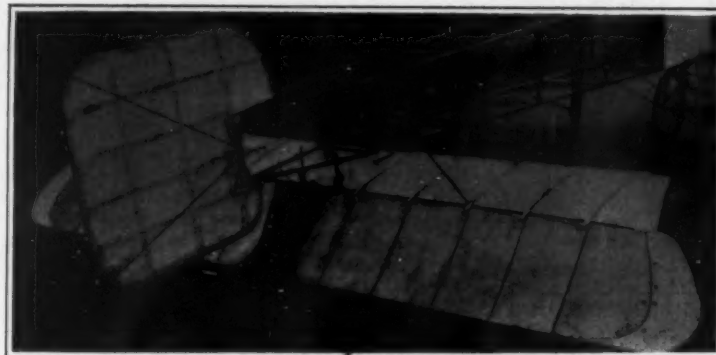Fig. 1.—Pégoud's Blériot monoplane at the start.

Fig. 2.—Tail of Pégoud's Blériot monoplane with downwardly convex elevator.

Technical Impressions of Pégoud's Flights[*]

A Scientific Analysis of the Principles Involved in These Spectacular Performances

WHAT courage and fearlessness coupled with ability to analyze flying movements sympathetically can do to increase the personal safety of the human flier was shown for the first time a few months since by Chevilliard, the chief pilot of the house of Farman, and was shown in masterly fashion. All observers were amazed and inspired by the curves and dives he carried out at the International Aviation Meet at Aspern. Voices have, of course, been raised against his foolhardy and apparently useless maneuvers. The daily press has commented from its scientifically indifferent but optimistic standpoint upon the doughty deeds of Chevilliard and other French aviators as Prévost, Gilbert and Brindejonc, and thus has called the attention of the laity to the importance of their work. The scientific press, however, has remained remarkably silent in regard to these feats. Not a single attempt has been made in its columns to explain Chevilliard's experiments nor to consider their value to the future development of aviation, a discussion of which could not fail to be welcome to the manufacturer and to the aviator. How little ground there was for this cool reserve may be seen from the happenings of the hour, the vertical and inverted flights of Pégoud, which at the moment are holding the attention of the whole technical world.

Pégoud made his first appearance over the aviation field at Johannisthal only a few days since, and shortly before that at Aspern, near Vienna, and the impression which his feat left on laity and unitiated alike was overpowering. For weeks before Pégoud's appearance aviators watched with intense interest for the vivid press reports of his flights, and the circle of interest widened with every report. Now that expectation has turned to wonder, now that we have become eye-witnesses of the dramatic spectacle of "looping the loop" in the air, we find so many superficial and subjectively colored reports that an attempt to avoid false impressions seems to be in place. For instance, Pégoud's method of bringing his machine into an inverted position is entirely different from what might be concluded from the reports of both foreign and domestic papers.

Let us consider Pégoud's vertical and inverted flights with the critical eye of the expert.

To carry out his evolutions, Pégoud must reach a height of 800 to 1,000 meters. Having reached this elevation, he shuts off his motor and allows his machine to run a long, straight stretch, directed downward at a scarcely perceptible angle, merely to increase the kinetic energy. A quick powerful stroke with the elevator (elevating plane) and a simultaneous charge of gas to the motor are sufficient to bring the machine upon end with a sudden jerk. A second short stroke of the elevator, in combination with the forced pull of the propeller, throws the apparatus completely on its back; this position is overcome and a complete somersault is avoided by an upward stroke of the elevator. Apparently this maneuver gives the pilot no special difficulty, indeed, he seems to take it as a matter of course, especially when a head wind aids the action of the elevator, as happened at Aspern and Johannisthal. The inverted flight consisted of a glide, directed downward at a sharp angle with intermittent action of the motor. The writer was most impressed by this phase of the flight. The importance of convex planes for safety has long been recognized; on account of the recent lively discussions as to whether the ventral or dorsal curvature of the wings has greater influence on the carrying power of the aeroplane. It becomes a matter of extreme interest that we are now able to observe the inverted wing profile "in natura." It appears now that with the concavity of the wings upward, the line of flight inclines

downward to an appreciable degree (8 degrees inclination to the horizon). Hence we conclude that the convex curvature of the under surface of the main planes lessens the lift-efficiency noticeably, especially when the upper surface of the planes is not similarly convex, but concave. This need not be taken to mean that ventral convexity of the plane profile is doomed; doubtless this

Fig. 3.—Pégoud's Blériot monoplane seen from the side. Note the slight convexity of the wings.

disadvantage would disappear or its importance be materially lessened if the ventral convexity were flattened and the dorsal concavity replaced by a slight convexity. Some further gain might be made through the use of Constantin's so-called "déviateur," which, according to the reports of French scientific journals, makes possible an essential increase in the co-efficient of convexity. Pégoud's flight in his inverted machine shows conclusively that pure convexity of the ventral surface combined with dorsal concavity is a principle entirely unusable in aeronautics. The succeeding stage (EF, Plate I), i.e., that of bringing the apparatus back into the normal position shows again plainly how inferior ventral convexity of planes is to ventral concavity in lateral stability. While the pilot was able easily and quickly to bring his machine from the normal to the inverted position, the return to the normal went less easily and less quickly, in all probability on account of the greater resistance which the inferiorly convex profile offered to any change of its absolutely stable position.

Maneuvering with the elevator is not alone sufficient to overcome this resistance. Through extremely vigorous warping an oblique position is reached (with the cross axis inclined to the horizon at an angle of 70 degrees

Fig. 4.—Unfolded parachute.

to 80 degrees (C, E, Plate I). The resistance which the increased surface of the side control offers in this phase to the upward directed pressure of the air and which is still more intensified by a stroke of this control, results in the tail lagging behind the now dipping head of the machine. Almost instantaneously, indeed, after an imperceptible drop, the complete vertical position of the long axis of the machine is reached (F, Plate II). Out of this phase the monoplane is easily brought back into the horizontal track by a light turn of the elevator and the changing of the side controls at the instant of the monoplane's transition from the laterally oblique to the vertical position when the lateral plane makes the downward acceleration of the head possible. This will all be plain from the sketch shown in Plate II.

These maneuvers were first carried out by Maurice Chevilliard with a Farman biplane, but he was not able to risk inverted flight on account of the dissimilarity in the span of the planes, but probably Pégoud got his first idea of the trick of flying upside down from Chevilliard. He could the better undertake the risk since he had at his disposal a Blériot monoplane which possesses all the peculiarities necessary. Certain important but not essential alterations made for safety consisted in exchanging the rudder of the ordinary 50 horse-power type of monoplane (Gnôme-motor) for one of the 80 horse-power type. In increasing the size of the rudder and strengthening the steering gear materially, the steering post was lengthened. It is a point of great importance that the main planes of Pégoud's Blériot monoplane are not set at a slight angle, but are horizontal. It is of great significance that the body of the machine is left uncovered, a fact which makes the machine very sensitive to control.

To sum up the characteristics of Pégoud's Blériot monoplane we have:

(a) Main planes of the simplest geometrical shape, rectangular with rounded ends. (b) Uncovered body. (c) Large steering surface. (d) Elevator convex downwards. (e) Light running gear, and (f) Neutral equilibrium—the condition sine qua non for his tactics, and at the same time typical characteristics of the unstable flying machine.

A résumé of Pégoud's tactics follows:

(1) Attainment of the inverted position (after increasing the momentum) through "rearing," brought about by an upward stroke of the elevator and an increase in the number of revolutions of the motor.

(2) Extreme and very sudden change of position through warping, at the same time the attainment of the oblique position, sinking of the head, accomplished by an exchange of rôle between elevator and lateral planes and the re-attainment of the upright position through the action of the elevator.

(3) Return to the normal position through a gradual acquiring of the laterally oblique position, then sinking of the head (change of rôle between rudder and lateral planes) until the forward rim of the planes lies parallel to the surface of the earth, thereupon righting of the machine by means of the elevator.

On the proper sequence of these phases and their correct inception and completion depend the success of these experiments. The advantage of the observation and intelligent application of these principles of the A B C of flying cannot be overestimated. For instance, "banking" (tipping laterally) would lose its terrors (of course, at a certain elevation) if the pilot would only learn to depend in such cases solely on lateral planes and elevator instead of on warping. If the surface of the lateral planes is large enough no difficulty should be experienced. Since every pilot, and especially the novice, may lose his head at critical moments, the constructor should take this lesson to heart and build
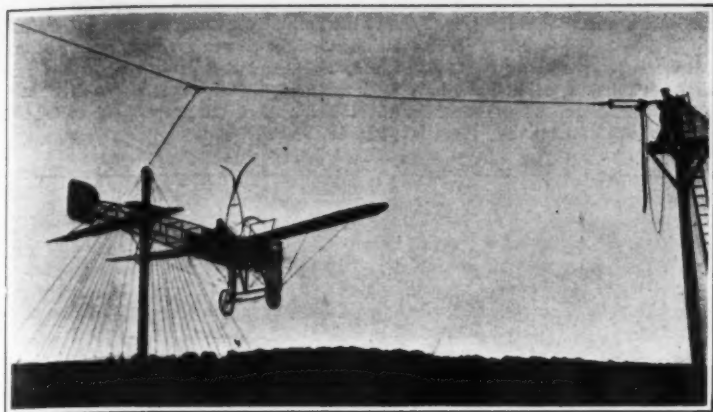
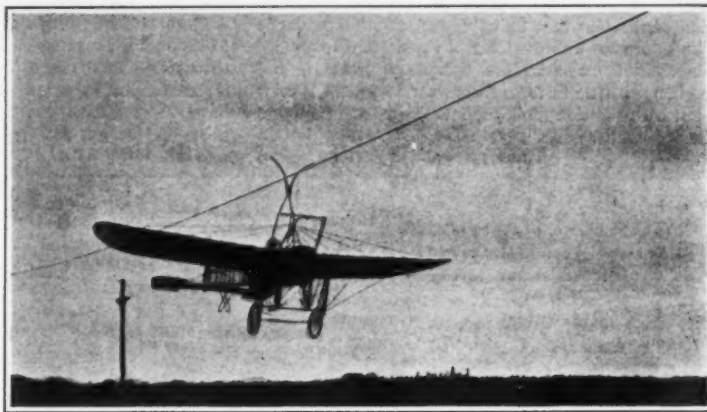Fig. 5.—Pégoud starting in his Blériot monoplane from the cable.

Fig. 6.—Landing on the cable.

the lateral plane, as large as possible and set them so that they shall not be in the lee of the elevator in any possible oblique position.

Pégoud performed these difficult evolutions in public only after long and careful preparation under the direction of Blériot. The experiments were carried out with the aid of a horizontally spanned cable for starting and landing which may prove useful for starting and landing on uneven ground and on shipboard. As may be seen from Figs. 5 and 6, this cable is supported by four posts, two at either end.

The monoplane is furnished with a block (Fig. 7) held vertically by shock-absorbing elastic bands, E.

Fig. 7.—Trestle and fork for the cable.

The block carries aloft a fork, A, into which the horizontal cable can slip and be secured.

Pégoud also made a successful parachute descent from his machine. Fig. 4 shows the parachute inflated by the stream of air from the propeller. The parachute was carried as a precaution during the experimental stage, but was discarded later. It is useful at elevations of 100 meters or more; any less descent failing to unfold it completely.

I should be unwilling to close without once more

Fig. 8.—Machine with closed parachute.

emphasizing the real value of Pégoud's attainments.

He himself regards as their ideal purpose the enlightenment of his colleagues, but neglects to further his ideal by publishing the details of his tactics. Hence, it remains to each one to reconstruct his art of steering by observation of his maneuvers and the sequence of their separate phases. Since personal equation must enter largely into any judgment of a scene enacted at so great a height, differences and errors of opinion must result even among experts, as I found to be the case among aviators at Aspern.

My purpose in writing this article has been to analyze the separate phases of inverted flight with reference to

the pilot's technique in steering, to emphasize the underlying principles for the advancement of the education of aviators and of aviation in general, and finally to give some hints to builders for future development. I hope that what I have said may be of assistance to aviators in comprehending the real facts in question.

The credit due Pégoud lies less in his discovery of inverted flight than in the fact that he has on the one hand demonstrated to his colleagues the value of a scientific understanding of flying machines and flying movements and their significance for many unexpectedly critical situations, and on the other hand he has most strikingly brought home to the remotest circles a con-
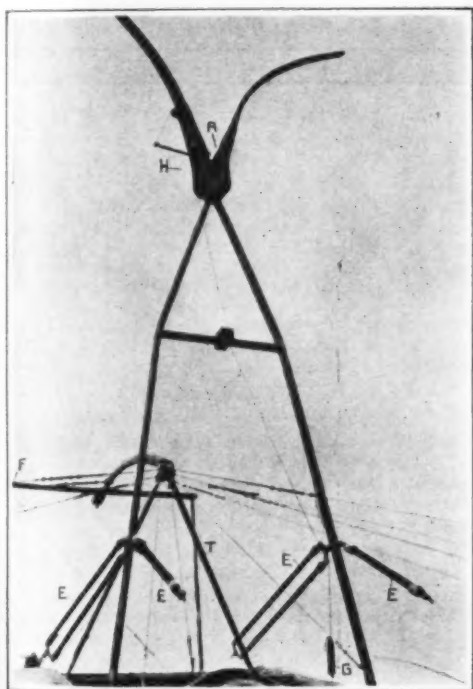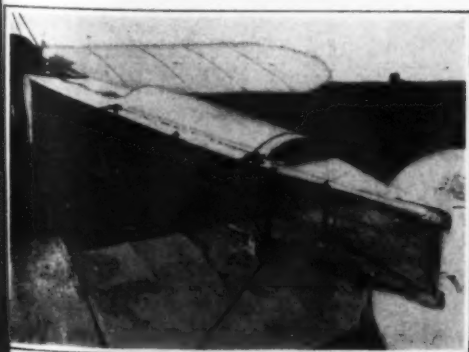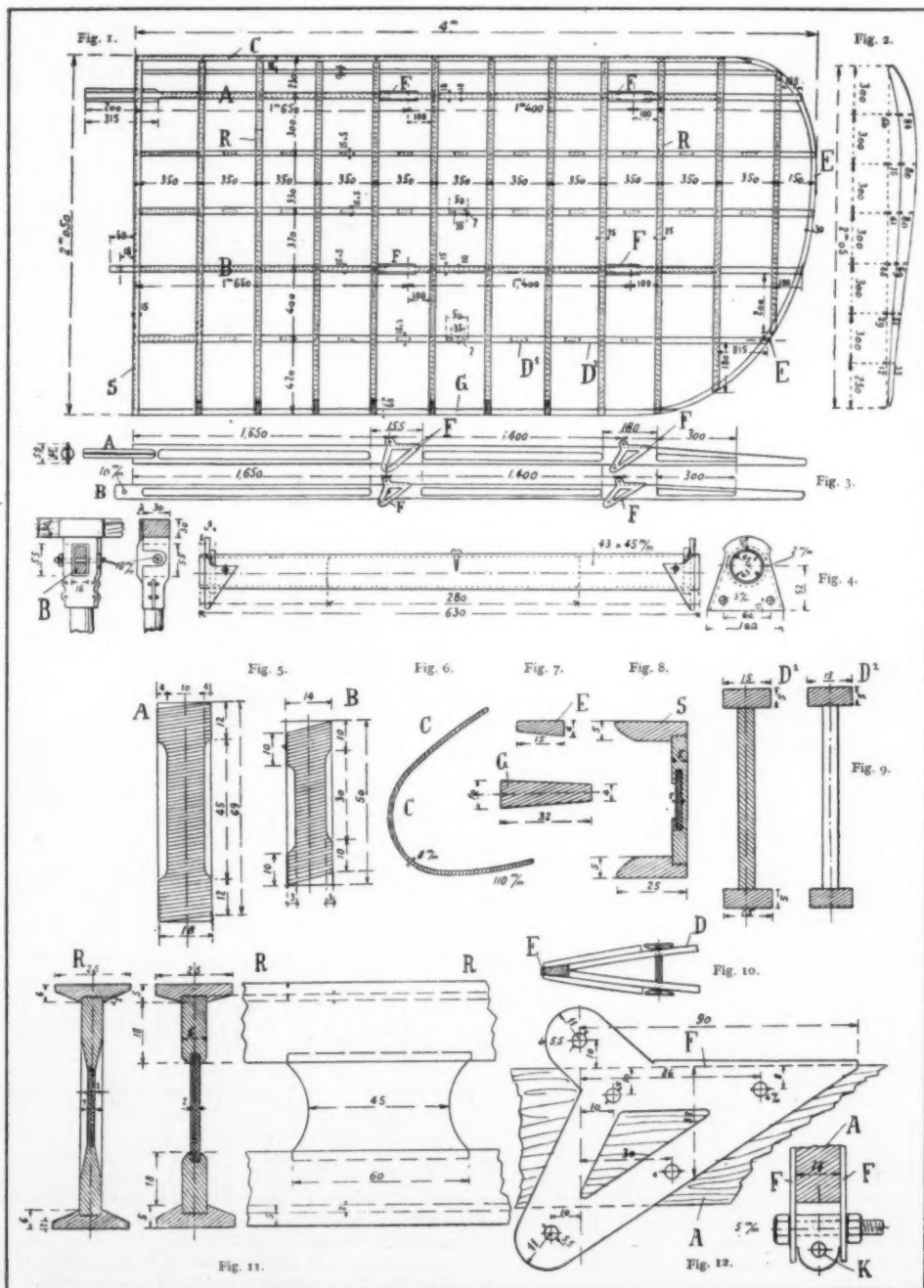

Plate I.—Sketch of the wings and their separate parts (after L'Aérophile, Paris).

A, forward rib; B, binder rib; C, anterior (or front) edge; D, strengthening braces; E, side edge; G, back edge; F, steel eye-plate for fastening the bracing cable with bolt K; R, ribs; S, reinforced rib.

ception of the fact that flying under scientific guidance will be the future's safest form of rapid transit.

The Blériot machines are extremely graceful, and have changed little in form from year to year. Blériot has put his attention mainly on the constructive detail of the apparatus.

Plate III, Fig. 6, shows how the cables are attached to the main planes which they support, anchoring them to the elongated mast. The construction of the wings is charted in Figs. 1 to 12, Plate I. The main planes have been greatly strengthened in comparison with those of former years, and the convexity decreased.

(Fig. 2 shows the normal convexity of this apparatus.)

The attachment of the ribs to the body is very strong (A, B, Figs. 1, 3, 5), and the forward rib A is firmly set in a steel cylinder. Strong eye-plates (F) of steel serve for the attachment of the bracing cables (Fig. 6, Plate III; Fig. 12, Plate I).

Plate II.—Schematic representation of Pégoud's inverted and vertical loops.

1.—INVERTED FLIGHT:
  A—Start.
  B—Slightly downward direction taken by machine.
  C—"Rearing" by means of elevator; motor working.
  D—Gliding of inverted machine.
  E—Oblique position acquired by warping.
  F—Vertical position—acceleration of the head.
  G—Righting through use of elevator.

2.—THE CLOSED VERTICAL LOOP:
  H—Flight directed slightly downward.
  J—"Rearing" as in C, overturning.
  K, L—Righting by means of elevator. Gliding landing.

3.—PLAY OF FORCES INVOLVED IN TURNING:
  (a) Forces maintaining direction:
    S—Gravity, 384 kilogrammes.
    Z—Pull of propeller and kinetic energy, about 130 kilogrammes.
    W—Resistance of wings and body.
  (b) Forces tending to change of direction:
    D—Rudder pressure.
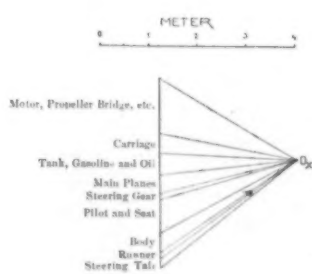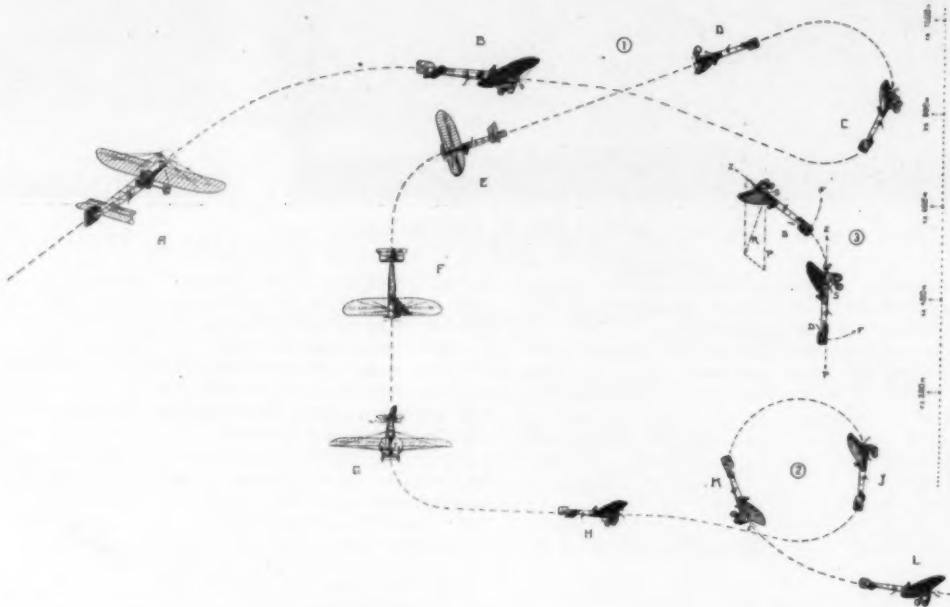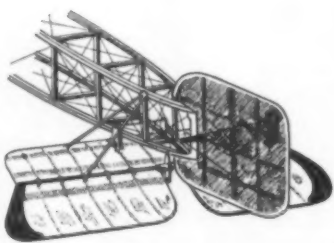   F—Centrifugal force.
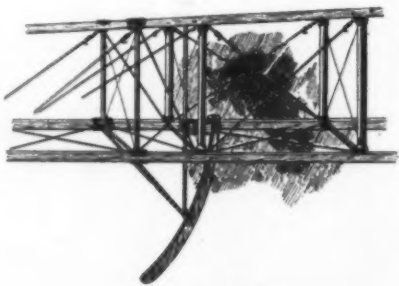   R—Resultant force of P and Z.
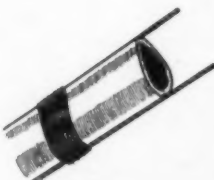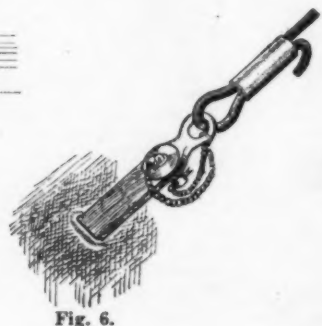

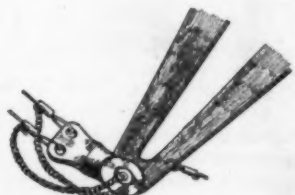

Fig. 1.

Fig. 6.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Plate III.—Pégoud's safe Blériot monoplane.

FIG. 1.—Graphic determination of the center of gravity and of the amounts of inertia by means of the string polygon. FIG. 2.—Tail steering gear (enlarged dimensions). FIG. 3.—Detail of body with runner. FIG. 4.—Axle of carriage. FIG. 5.—Attachment of bracing cable to the back of wings. FIG. 6.—Waist of rudder.

Stellar Photometry[*]

By the Use of the Photo-Electric Cell

By W. F. Schulz

THE great sensitiveness of the photo-electric cell has been shown experimentally by Elster and Geitel,[1] by Nichols and Merritt,[2] and J. G. Kemp.[3] From the results of these investigations it seemed that such a cell might be used to measure the light from fixed stars,

* Reproduced from the Astrophysical Journal.
[1] Physikalische Zeitschrift, 13, 468. 1912.
[2] Physical Review, 34, 476, 1912.
[3] Ibid. (2), 1, 274, 1913.

and its variation. The following is an account of some successful preliminary experiments in an attempt to make such measurements.

Several cells of the form shown in the accompanying diagram were prepared in the following way. The anode was a platinum wire about 0.5 millimetre in diameter, bent into a rectangular loop about $1 \times 1\frac{1}{2}$ centimeters on the side, the terminal passing through a glass sleeve 3 or 4 centimeters long. On the wall of the

tube facing the plane of this loop was a layer of potassium which formed the cathode. In order to have good contact at the cathode a layer of silver was deposited on and around the platinum terminal on the inside of the bulb. The bulb proper was about 5 centimeters in diameter. Potassium was distilled from a similar bulb into a second one, then poured into a tube just outside the bulb of the photo-electric cell and finally distilled upon the silver surface surrounding the cathode terminal.

A little hydrogen gas was then introduced by heating a strip of palladium contained in a side tube. A potential-difference of 560 volts D. C. was applied to the electrodes P_1 and P_2, P_1 being negative, with a lamp resistance of 3,000 ohms in series with the cell. When the circuit was closed for a few seconds the bright metallic colors of the hydrogen compound appeared at once on the potassium. There was a uniform soft glow over the entire surface of the metal, the rest of the bulb being non-luminous. It was found necessary to use a rather high potential-difference with a resistance. When a potential-difference of 300 volts with little or no resistance was applied, the discharge took the form of an arc rather than that of a glow, and the current rose rapidly, in one case even melting the electrode.

The circuit was broken when the surface of the potassium had assumed a brilliant violet-blue color and the hydrogen was carefully pumped out and was replaced by a small quantity of helium. All traces of oxygen were removed from the helium by passing it through a tube in which potassium was evaporated, before introducing it into the cell. The photo-electric cell was next connected in series with a sensitive galvanometer and the lamp resistance, and a potential-difference of 300 volts was applied. The light from a small gas flame was allowed to fall on the metal of the cell, and the pressure in the latter was varied by small steps until the galvanometer deflection was a maximum. The tube was then sealed off and proved to be constant for a period of several months.

For measuring very small intensities of light two different methods were used. In the colder winter months, especially in the open observatory, the temperature of the cell was so low that the natural leak through the dark cell was negligible, and the photo-electric current was measured directly by the rate of deflection of a quadrant electrometer. Toward the spring, however, when the temperature rose, the natural leak through the cell increased rapidly with the temperature, and it was found necessary to compensate this current by means of an independent circuit as shown in the diagram. The anode of the cell was connected to a storage battery of 160 cells, the negative terminal of which was earthed. The cathode was earthed through a high resistance R_1 and connected through a discharge key to one pair of quadrants of a Dolezalek electrometer. In the compensating circuit a battery of 3 cells sent current through a variable resistance R_2R_3 of 20,000 ohms, and the

negative terminal was earthed. The other pair of quadrants was connected to R_3R_2 by means of a traveling plug. By this arrangement the "dark current" could be completely neutralized. V_1 was varied from 150 to 320 volts. This was not quite the upper limit at which the cell could be used, but 350 volts was too large, and the photo-electric current reached a value beyond that of saturation. R_1 was a very high resistance of xylol with just a trace of pure alcohol. The sensitiveness of the electrometer was such that a potential difference of 20 volts on the needle and 1.4 volts between the quadrants produced a deflection of 120 millimeters at a scale distance of 2 meters. The deflections were very steady. The cell was tested by the light from a
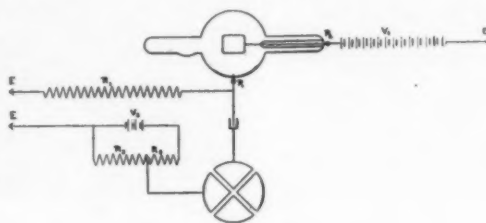

Diagram of apparatus.

small incandescent lamp, which was cut down by passing it through two large crossed Nicol prisms. The cell was mounted in a light-tight box, carefully blackened inside, and closed by means of a shutter. A long closed tube was screwed into the opening of the box, and the lamp placed in this at 1.5 meters distance from the cell. The Nicols were inserted between lamp and cell, with a device for measuring and varying the angle between them. The candle-power of the lamp measured on a two-meter photometer with Lummer-Brodhum screen was approximately 0.003 at 6 volts. The deflections of the electrometer were easily read even when the planes of polarization made an angle of 85 deg. with each other. The intensity of the light which passed through an opening of 1 square centimeter area at the cell was therefore $0.003 \times \cos^2 85/1.5^2 \; 0.000010$ candle meters.

It has been shown by Angström that the energy flowing from an amyl acetate lamp is approximately 10^{-3} gram calories per square centimeter at a distance of

1 meter. Assuming the Hefner unit and the candle-power to be equal and the distribution of energy to be the same in both lamps, we find that the quantity of energy incident on the cell is approximately 0.000010×10^{-3} gram calories or 4.19×10^{-4} ergs. This produces a deflection of the electrometer which is easily read. So far the light from two stars has been measured by means of this cell; in December 1912, that of *Capella* and in April 1913, that of *Arcturus*. The cell in its light-tight box was mounted on the 12-inch equatories at the observatory of the University of Illinois, and placed in such a position beyond the focal plane of the objective that the circle of illumination on the sensitive surface of the cell had an area of about 1 square centimeter.

On the cold December nights the natural leak through the cell was almost zero, and the photo-electric current was measured by the rate of the electrometer deflection. With 40 volts on the needle and 160 volts on the cell, the rate of deflection at a scale-distance of 2 meters was 20 millimeters in 30 seconds. With 200 volts on the cell, the rate was 18 millimeters in 20 seconds. These deflections were repeated without difficulty.

In April 1913, another set of readings was taken with the light from *Arcturus*. This time the dark current had to be compensated. With 60 volts on the needle and 250 on the cell, the deflection due to the photo-electric current alone was 22 millimeters. This was reduced to zero each time by varying the resistance R_2. With 60 volts on the needle and 300 on the cell, the deflection when the cell was exposed to the light of *Arcturus* was 48 millimeters; with 60 volts on the needle and 325 on the cell the deflection was 190 millimeters; and with 80 volts on the needle and 325 on the cell the deflection was 248 millimeters. The sensitiveness of both cell and electrometer can be increased.

These measurements seem to show that it is possible to use the photo-electric cell for astrophysical investigations. The present research is being continued along various lines. It is planned to compare the sensitiveness of the photo-electric cell with that of the selenium cell, and to study the influence of temperature upon the "dark current," the effect of the wave-length of the incident light upon the lower limit of sensitiveness, and the use of various alkali metals for the sensitive layer.

These measurements were made at the suggestion of my friend Dr. Jakob Kunz, to whom I am deeply indebted for the benefit of his invaluable experience in making the cells and for assistance in conducting the experiments.

Flexible Metallic Tubing*

THE amount of attention recently attracted to oil fuel and to devices for storing and handling it may justify a brief account of an important manufacture which has rendered great services in regard to the transport of oil, and especially its transference into the tanks of ships. For many years tubes or hose made of rubber held the field for all purposes where great flexibility was essential. In cases where the employment of rubber was out of the question short lengths of rigid tube, with somewhat ungainly flexible leather joints, were substituted, and for certain requirements woven canvas hose did good service; but there were many purposes, especially those entailing the conveyance of oil, for which neither rubber nor any of the above substitutes could be used with advantage, and for which a tube of metal possessed of considerable flexibility was desirable.

When the new metal tubing was first brought into public notice the late Sir Frederick Bramwell said that the idea of a tube with a continuous joint from end to end was quite subversive of all preconceived theories of sound construction, and he admired the ingenuity of an invention which caused the joint to become tighter as the internal pressure increased. In the formation of the tubing a plain strip of steel or other metal is passed between a graduated set of mollets which bend it into external curves and at the same time cause the curved links to interlock while passing round the mandrel on which the tube is coiled. For certain purposes a thin thread of asbestos is at the same time tightly wound between each strand, so that the tube becomes a continuous interlocked ribbon of metal with a suitable packing along the joint. Flexibility is insured by the piston-like motion of a small corrugation within a larger one.

PREPARATION OF THE STRIP.

The metal strips, either of steel or of copper, are received from the manufacturers in the form of coils, hot-rolled, and are of various thickness and weights, ranging from $1\frac{1}{2}$ hundredweight to $3\frac{3}{4}$ hundredweight in steel, and from 2 hundredweight to $4\frac{1}{2}$ hundredweight in bronze. These coils when finished may be 1,000 feet or even in some cases 3,000 feet in length. The first step is to clean the strip thoroughly from any adherent scale or foreign matter, and for this purpose it has to be unwound and made up into a fresh coil in

*Reproduced from the Engineering Supplement of the London *Times*.

such a way that the strands of metal no longer touch one another. The coil thus opened out is immersed in a tank or bath of dilute acid, in which it may remain for five or six hours, so as to dissolve away all the impurities and leave the metal surface bright and clean. From the acid bath the strip goes into an alkaline bath to neutralize the residual acid, being afterward well washed in clean water to remove all traces of the chemicals. It is then cold rolled to the exact thickness required, and bright annealed.

In the next operation the strip, which may be in some cases from three to five times the width needed for the tube-making, is passed through a machine that slits it up into any required number of narrow bands, each of which, as it leaves the cutters, is wound into fresh coils. It is possible to construct the tube of any tough metal in the form of strip, and of copper, brass, nickel, and aluminium can all be employed for the purpose.

GALVANIZING AND SHAPING.

For the great majority of uses the steel strip has to be galvanized, to protect it from the action of the weather, and for this purpose it is washed in hot water and conveyed into a long, stoneware-lined bath in which it traverses the electrolyte, the speed at which it moves through the bath being regulated in such a way that the time elapsing between its entrance and exit just suffices to coat the metal with the requisite amount of zinc. From the galvanizing department it passes at once to the shaping machine, when the entire process of bending it and coiling it to form the tube is effected in one operation.

As the diameter of the finished tube may vary from 1-16 inch up to 12 inches, it will readily be understood that the machines fitted for this part of the work differ considerably in size and speed of drive. A very small tube like a quill will need but little power for its production, while a heavy machine will have to be employed for making a 12-inch tube from a plain strip 50 millimeters wide by 2 millimeters thick. Whatever the size of the finished tube may be, the mode of forming it is precisely the same, and involves the use of numerous sets of steel mollets which produce the necessary amount of corrugation and finally coil the strip round a mandrel of the requisite size. As it quits the machine the tube is received in a wooden trough, which must be sufficiently long to contain the entire length of the section. In certain sizes the completed tube may run to as much as 100 feet in length, and even the very large tubes, 10

inches and 12 inches in diameter, are occasionally made in lengths of 30 feet to 35 feet.

USES OF THE TUBING.

In many industries the adoption of metallic tubing which will not char and which is sufficiently rigid to withstand the application of heavy weights, has found a useful place. Thus for laundry purposes, in which rubber tubing was at one time employed to carry the gas or steam to hot irons, rubber has been superseded by metallic tubing. An advantage claimed for this form of tubing is that it will not kink, and thus cut off the supply of gas. Where rubber tube is in use to convey gas to a burner, as is often the case in chemical laboratories, the extinction of the gas at the burner, owing to kinks in the tube, is a frequent cause of serious leakages. For superheated steam flexible metallic tubing will resist pressures and temperatures quite beyond the range of possibility with rubber hoses, however carefully they may be armored with an external sheath of wire or metal. When manufactured in a special way the metallic tubing can be made to withstand extremely high pressure, and tubing has been supplied to the British Admiralty guaranteed to take a pressure of 5,000 pounds per square inch.

Mineral oil has a very destructive action on India-rubber, and partly in consequence of this fact, and partly owing to the possibilities of making the metal tubing of very large diameters up to 12 inches, the use of rubber for conveying oil has been almost wholly discontinued since the introduction of metallic tubing, which is in general use for pumping oil into the reservoirs from tank-steamers, and for the purpose of taking up oil at sea.

Mercury and Musts

THE influence of mercury on alcoholic fermentation has just been studied by M. P. Nottin. The presence of mercury in a liquid in a state of fermentation produces two distinct phenomena. The mercury feebly attacked by the natural acid must produce toxic salts, which, according to their dose, keep back or hinder entirely the development of the yeast. Secondly, the mercury as a metal increases the production of the yeast, because it continually removes from the must its carbonic acid by a phenomenon of a purely physical order, and thus allows the yeast to breathe and vegetate more easily. Platinum and porous substances produce the same effect.—*Chemical News*.

A Norwegian whaling steamer of South Georgia just after the shot.

A humpback whale is fast, and the harpoon line (on the port bow) is being drawn in by a steam winch located behind the mast. The chopped-off flukes of a dead whale show amidships. Note in the foreground a Wilson's petrel (*Oceanites oceanicus*) which migrates northward to our coast every year, and farther back a Cape pigeon (*Daption capense*).

The whale-slip, Grytviken, Cumberland Bay.

This cove is the old "Pot Harbor" of American sealers. The tiny land-locked haven nowadays greets the visitor through his sense of smell long before he rounds the point which shuts the entrance from view. The "whaly" odor increases amain as one enters the cove, which might be likened to a great caldron filled with the macerated bones of whales.

A Desolate Island of the Antarctic[*]

South Georgia in the Latitude of Cape Horn, the Greatest Whaling Grounds of the World

By Robert Cushman Murphy

THE cold white hills of South Georgia were a most welcome sight after five months of sea life. That desolate isle, which for more than a hundred years has been the scene of ruthless sporadic destruction of fur seals and sea elephants, has of late become the base of the greatest whaling grounds in the world. The modern industry was instituted by a Norwegian of both north and south polar fame, Captain C. A. Larsen, who in 1893 touched at South Georgia with the "Jason" while on his expedition which led him into the Antarctic Sea east of Graham Land. Eight years later Larsen commanded Nordenskjöld's vessel, the "Antarctic," which likewise visited South Georgia, and upon returning thence he determined to establish a whaling station of the modern Norwegian type. Thus the *Compania Argentina de Pesca* was incorporated in Buenos Aires, and the right of locating in Cumberland Bay, South Georgia, was secured. Larsen's success led to the establishment of other plants, so that now in addition to the Argentine station there are five Norwegian and two English companies operating in various harbors along the northeastern seaboard of the island, and more than two thousand men are at work manufacturing oil and fertilizer and other products of the whale's carcass.

Phenomenal success has attended the whole industry; more than five thousand whales have been towed into the ports of the island in one year; twenty carcasses are sometimes received at a single station during twelve

hours; and two and a half million gallons of oil have been tried out at one station during a season, to say nothing of whalebone and guano. Several of the companies have yielded a profit of more than one hundred per cent. to the stockholders. And still the whales show slight signs of diminished numbers, although they are said

Blackfish (Globicephalus).

During the long cruises in the South Atlantic many days passed without sight of living creature, a monotony counterbalanced by the occasional excitement of blackfishing according to the ancient method with hand harpoon.

to have become more difficult to capture than they formerly were. At present transportation is maintained between South Georgia and Buenos Aires; a British magistrate resides at Cumberland Bay, which has been declared a port of entry; and legislation designed to control the destruction of wild life has finally been enacted.

The whale, taken in greatest numbers at South Georgia, is the southern humpback or *knöll*, which is the mainstay of the industry. The slenderer and less profitable finback is also abundant, and is shot whenever the former species is scarce or shy. The giant blue whale or sulphurbottom is third in importance, while sperm and right whales are taken more rarely, perhaps only once or twice a year. The height of the whaling comes during Christmas season, that is about midsummer.

The expedition to South Georgia Island, conducted jointly by the American Museum of Natural History and the Museum of the Brooklyn Institute of Arts and Sciences, returned last May after an absence from the United States of exactly one year. The itinerary of the New Bedford whaling brig "Daisy," which carried the museums' representative, was pleasantly roundabout, including in its course several West India islands, the Cape Verdes, the Brazilian island of Fernando de Noronha, and the uninhabited South Atlantic islet Trinidad, and affording opportunity for field work at each of these interesting tropical localities. The objective point of the voyage, South Georgia, lying in the latitude of Cape Horn, was not reached until November 23, 1912.

Although the long cruises in the tropical Atlantic,

A bull sea elephant. Bay of Isles.

Slow, unsuspicious, gregarious, the sea elephants can be hunted profitably until they have gone to their ancestors and the calamity of the Antarctic fur seal is repeated.

' A Parthian glance as he retreats.

A sea elephant can progress for a short distance at the speed of a brisk walk. Note that the inflatable sac on the snout of this bull is collapsed because the nostrils are open.

where not infrequently many days passed without sight of a bird, fish or other living creature more conspicuous than a Portuguese man-o'-war, were sometimes monotonous, such periods were well balanced by the occasional excitement of sperm-whaling or blackfish-hunting. The latter cetaceans were frequently encountered, and a good series of skulls of the tropical species was secured for the museums, the animals being captured with hand harpoons according to the venerable methods of the sperm-whale chase. Blackfish travel in large shoals, often in company with porpoises. I have seen both species, mixed more or less indiscriminately, swimming along peaceably together in groups of three or four, the individuals of each group almost touching sides. When blackfish are moving leisurely at the surface the back fin is exposed most of the time, but occasionally they lie idly, with the head, fin and flukes all under water and only the rounded angle of the high caudal ridge projecting above. When they rise to breathe the great square "junk" or snout, which yields the most valuable of all lubricating oils, is commonly thrust out of water as far as the eyes and the angle of the mouth. They are rather wary cetaceans, often avoiding the whaleboats with tantalizing skill, leading on the oarsmen only to render the pursuit hopeless in the end. Lying quietly at the surface they wait until the boat draws almost within striking distance and then "let go," as whale-men say, that is, they sink straight down without appreciably altering the inclination of the body. From the mast-head I have watched them thus lowering far down into the clear water until they became indistinct shadows. Within a few moments they reappear a short distance away, and sometimes, as if in mockery, raise their hinder ends out of water and beat the surface ten or a dozen times with the flat of the flukes, making a loud tattoo—a trait which recalls the "lob-tailing" of the right whale. If, however, the blackfish harpooner be so fortunate as to make a successful dart, the members of the herd gather about their wounded comrade and it then becomes comparatively easy for the other boats to select and strike their victims. Once fast, the struggle is but begun, for blackfish are strong fighters, sometimes tearing out even deeply buried irons. Usually they pull straight away for a short distance, and then resort to dodging tactics, jerking the boat violently from side to side or spinning it end after end. As the prize becomes exhausted and the boat is drawn close, there is a final flurry in which the captive lashes itself back and forth under the bow with terrific jerks, so that quick and skillful work is required in lancing.

In the South Atlantic, visible animal life was far more abundant than we had found it within the Tropics. Vast flocks of petrels of many species were our constant companions, and during rough weather numbers were caught on fishlines from the stern of the vessel, an exciting form of angling, especially if the game chanced to be an albatross or giant petrel with the baited bent nail at the end of a slender hand-line jammed in the hook of its bill, the bird being held only by its own resistance. The smaller petrels such as Cape pigeons, were caught on fishhooks and were hauled from the air as animated kites after they had pounced upon the trailing baits and had started to fly off with them.

The day after we had "made the land" at South Georgia the "Daisy" was towed by one of the whaling steamers into King Edward Cove, Cumberland Bay. This cove is the old "Pot Harbor" of American sealers, a term which has been preserved in a translated form as the name of Captain Larsen's whaling station—Grytviken. The tiny, land-locked haven nowadays greets the visitor through his sense of smell long before he

In whaling trim.

The "Daisy" of New Bedford, the whaling brig which carried the expedition to the Antarctic and had previously been to Kerguelen Land and twice to South Georgia.

King penguin (A ptenodytes patachonica) incubating its single egg. Bay of Isles.

A king penguin carries its egg on the instep covered by a fold of the skin on the belly. The sexes relieve each other in the duties of incubation.

rounds the point which shuts its entrance from view. The "whaly" odor increases amain as one enters the cove, which might be likened to a great caldron so filled with the macerated bones of whales that they not only bestrew its bottom, but also thickly incrust its rim to the farthest highwater mark. During the next few days I discovered that not King Edward Cove alone, but indeed the whole beach of the south fjord of Cumberland Bay, a shore line of more than twenty-five miles, is lined with an almost inconceivable number of bones, mostly of the humpback whale. Spinal columns, loose vertebræ, flipper bones, ribs and jaws are piled in heaps and bulwarks, and I could count seventy-five or one hundred huge skulls without moving from one spot. The region is one enormous sepulcher, yet no one can guess how many hundreds or thousands of flensed carcasses have been carried out to sea by the tide, and so have sunk their skeletons in the deep. Such reckless waste of a material which when manufactured into fertilizer is worth several pounds sterling a ton, was due to the exceeding abundance of whales in South Georgia waters and consequent neglect of all products of secondary importance to the blubber oil. But now the companies are required by law to utilize the entire carcass of the whale, and they have either installed bone-boiling and guano plants at their stations, or have sub-let this branch of the industries to "floating factories," that is, vessels especially fitted for the purpose. One of this type, a 2,000-ton full-rigged ship, was so occupied at the time of our visit.

During our sojourn in Cumberland Bay, the time was occupied with trips into the surrounding mountainous country, particularly about the magnificent west fjord of the bay, a section reached overland from Grytviken through a high, extinct glacier bed, parts of which are smoothly paved with small fragments of shale packed edgewise by the ice in the manner of a mosaic. This pass is, curiously enough, the route taken by sea birds, particularly terns and skuas, in flying from King Edward Cove to the west fjord lakes. It seemed odd to meet flocks of terns 1,700 feet up in the mountains. The summit of the pass is marked by a stone cairn from which the way descends abruptly on the west fjord side to the lake basins in the ancient moraine. There are five transparent lakes, no two on precisely the same level, and the largest nearly half a mile long. Intermingled with them are low, irregular hillocks covered with tussock grass, and at the seashore the land rises again, ending in bold cliffs.

In this attractive area it is but natural that the majority of the twenty-three species of birds which breed on South Georgia can be found. The native gulls, terns, titlarks, ducks and the larger Tubinares nest upon the ground, trusting the safety of their eggs to protective coloration, concealment or constant guard, but the lesser petrels nest in deep burrows in order to escape the predatory skua gull, the universal enemy of every living creature it can master. Extraordinarily populous among the many inhabitants of the tussock hillocks I found the petrel Procellaria æquinoct ialis, the "black night hawk" of our sailors and "shoemaker" of the Norwegians. At sea I had often caught these birds, which exceed our herring gull in size, on pork-baited fishhooks. In the west fjord section they were nesting in burrows which they had dug through the frozen ground to a depth of a yard or more, using both feet and bill in the process, and the chatter or "singing" of the subterranean tenants, a pleasant and rather musical sound, usually revealed their presence before the nest entrances under the spreading hummocks were noticed. Early in December nearly all nests contained the single white

The petrel.

Called "black night hawk" by sailors and "shoemaker" by Norwegians, at entrance of nest. The chatter or singing of these subterranean tenants is a pleasing sound, usually revealing their presence before the nest entrances under the spreading hummocks are noticed.

A blue-eyed shag (Phalacrocorax atriceps georgianus) brooding her young.

In this beautiful species the ring of bare skin about the eye is cyanine blue. The feathers of the crest, back and wings are richly iridescent. The birds are of more gentle disposition than our northern cormorants and will allow themselves to be stroked while on the nest.

"Beach Master" with a small herd of cows.

The question as to whether sea elephants are extremely polygamous is still unsettled. Certainly bulls of this type attack any other bull which comes into the vicinity. Cumberland Bay.

egg which was often soaking in a pool of muddy water thawed out by the sitting bird. When drawn out of their holes the shoemakers screamed in an ear-splitting key and bit and scratched savagely, but if set free they squatted on the ground stupidly for awhile before taking flight. During the day many flew in from sea with a shrill whistling of their stiff wing quills, and I often surprised others apparently sunning themselves in front of their burrows.

The greater part of our stay at South Georgia was spent at the lonesome Bay of Isles, and at Possession Bay where in 1775 Captain James Cook set up his colors and claimed the dreary land for his king. At the latter place our anchorage was all but inclosed by a curving wall of valley glaciers the grandeur and proportions of which made them quite outclass the moribund glaciers of the Alps. The difficulty of working at these harbors was very great indeed, because an ordinary camp outfit proved inadequate for the conditions encountered. South Georgia is a region of almost continuous violent gales, and my light tent was worthless. It was impossible to keep an oil stove burning within it, so that I suffered considerably from the cold while preparing bird specimens, and, moreover, the tent blew down frequently, exposing everything to the snow and sleet. Eventually it blew to shreds. Very often blizards made it impossible for a boat to leave the ship; and sometimes we were stormbound for three successive days.

Since the long-gone days of the fur seal harvest at South Georgia, when a hundred thousand "golden fleeces" a season were sometimes taken by "Argonauts" chiefly from Long Island and New England ports, the isle has been best known as a home of the sea elephant.

The Antarctic species of this largest of seals differs markedly from the Californian race, and formerly had a circumpolar distribution. The great brutes being abundant as well as comparatively inoffensive and easily killed, a relentless pursuit of them was conducted wherever they could be taken on shore, or from Juan Fernandez southward and eastward to the Falklands, and throughout the isles of the South Atlantic and Indian oceans to the outliers of New Zealand. In many of its ancestral haunts the sea elephant has long since been wiped out of existence, but on South Georgia it had until recently a stronghold second only to Kerguelen Land. It is true that the heavy toll of "elephant oil" exacted of South Georgia in the nineteenth century brought the animals at several periods near the verge of extinction; there is a record that in 1885 the crew of a Connecticut schooner, which made a voyage thither in search of both oil and furs, were able to find only two sea elephants during a stay of ten weeks. But this example is perhaps without a parallel, and in any case sea elephants had been fairly abundant of late years in all suitable harbors and fjords of the island until three or four seasons ago. Since then the existence of the much persecuted animals has been threatened probably more seriously than ever before by the business-like and thorough ravages of one of the whaling companies which takes seal oil as a side line of whaling.

Soon after our arrival at South Georgia we began to fall in with sea elephants. As nearly as I can determine from my subsequent observations, filled out from the accounts of experienced sealers, the life history of these animals is very briefly as follows: The single "pups" are born on shore in early spring (September, October),

and the old ones pair immediately afterwards while the young are nursing. For a period the adults then lie ashore, moving little, and of course feeding not at all, while they grow gradually thinner, supporting life upon their own plenteous blubber. The pups are more active, frequently entering the water and playing with one another in schools. They seem to be weaned at an early age, probably during November. After six or eight weeks the mature animals go into the sea where they feed, and may journey hundreds of miles, but on this part of their lives there is a gap in our information. A few slothful individuals continue ashore, and I have seen bulls of this sort in a state of pitiful emaciation, lying in wallows either alone or with four or five cows, as late as March first. Early in January well nourished adult sea elephants begin to "haul up" from the sea again, and as the month advances considerable herds of exceedingly fat females gather on the upper beaches. The males come later, during February and March, and are then of enormous bulk and very lethargic. These are the "March bulls" which sealers prize, for one such may yield five or six barrels of oil. They locate wherever they can find company, and if undisturbed remain in sleepy ease throughout the remainder of the Antarctic summer and the autumn. During the winter they divide their time between the land and the adjacent waters, and are in prime condition when they come ashore for the breeding season of the following spring.

The attribute *par excellence* on which the sea elephant's reputation rests is large size. For a number of weeks after arriving at the Bay of Isles I saw no animal more than thirteen feet in length, except the dismal remains of bulls slain in former years. But during February, seventeen and eighteen-foot bulls, just out of the sea, were taken a dozen times, and on the last day of the month the record seal, twenty feet six inches long, was killed in Possession Bay. I did not see this huge brute until after it had been stripped of blubber, but as it measured twenty-one feet four inches (651 centimeters) while lying on its back in its flensed condition, the mate's flesh measurement is certainly not exaggerated. Our second largest bull was shorter than this by two feet. When the animals are in best condition (from a sealer's point of view at any rate) a large sea elephant's girth may very nearly equal its extreme length. The fattest I saw was a bull eighteen feet four inches long, and so round and distended that it had the appearance of being pneumatic, and inflated under high pressure. Seven men could barely turn its body over with the aid of ropes and hand holes in its skin, even after half the blubber had been removed and a trench had been scooped under one side of the carcass. The blubber was a trifle less than eight inches thick in the center of the breast, and the brute yielded almost as much oil as a young sperm whale. I gained a good idea of the weight of a sea elephant by cleaning up the skulls, for there was no man among the crew of the "Daisy" who could pick up and carry the head of a large bull until the hide and fat had been cut away from it.

The question as to whether the greatest of the seal kind is to be preserved at South Georgia depends largely upon the results of an investigation of the status of whales, seals and penguins, now being conducted for the British Colonial Office. The difficulties and expenses of the fishery make it almost impossible for any species of whale to become completely extirpated, however persistently it may be chased, but the unfortunate sea elephants have no such hope of preservation. Slow, unsuspicious, gregarious, they can be hunted profitably until the last one has gone to his ancestors and the calamity of the Antarctic fur seal is repeated.

Palæobotany: Its Past and Future*
By Dr. Marie C. Stopes

PALÆOBOTANY has already passed through three main phases of its development: the first, when fossil plants were supposed to be the spontaneous ornamentations of stones by an exuberant nature which blindly disported itself. The second, when they were realized as being the remains of extinct life, but were described without the light of a fundamental and unifying hypothesis; and the third, when a scientific knowledge of their structure made comparison with recent plants possible, and it was realized that they threw light on the evolution both of the living plants and the existing continents. In this phase we are now at work.

Even at a time when the true nature of animal fossils was realized, and their occurrence causing much discussion, references to plants were few. John Ray wrote in 1693: "Yet I must not dissemble, that there is a Phænomen in nature, which doth somewhat puzzle me to reconcile with the prudence observable in all its works, and seems strongly to prove, that nature doth sometimes *ludere*, and delineate Figures, for no other end but for the Ornamentation of Some Stones, to entertain

and gratifie our Curiositie or exercise our Wits. That is, those elegant Impression of the Leaves of Plants upon Cole-Slate."

A number of little-known books written between 1693 and 1781, illustrate the importance of fossil plants to those authors who took the flood as a fact, and were puzzled to account for the existence of plants at all on the earth—for only the animals had been preserved in Noah's Ark. Among pioneers of Palæobotany, it is interesting to discover the mystic Swedenborg, who published the first plates of fossil plants in Sweden, a country now famous in palæobotany through Prof. Nathorst's work.

At the beginning of the nineteenth century, palæobotany suddenly became scientific. The works of Brongniart, Sternberg, Schlotheim, and others created a new epoch in the science. In 1828 Sprengel described silicified fern stems from their anatomical structure. In 1833 Witham published his book on "The Internal Structure of Fossil Vegetables," and this was shortly followed by a large work giving beautiful drawings of the anatomy of Psaronius and other fossils by Corda.

As a forerunner of the newer type of work which crystallized round Williamson, one may here place Sir Joseph Hooker, who was much interested in and published several valuable papers on the structure of

fossil plants, and who held from 1846 to 1848 the official post of botanist to the Geological Survey. The post has lapsed for all these years, and to-day, when the surveys of other civilized countries have their official palæobotanists, it would be interesting to know why England, the first to originate the post, and the premier coal-producing country in the world, should be minus so valuable a servant. Concerning the extreme value and originality of Prof. Williamson's work, little need be said. He may justly be described as the father of botanical palæobotany. It was Williamson who, in face of the opposition of every living botanist of his day, propounded the fact that the lower vascular plants could develop secondary wood without, as the French school of palæobotanists maintained, thereby qualifying for inclusion among the Angiosperms. Writing of Williamson's work on Cambium, Solms Laubach said: "This is a general botanical result of the greatest importance and the widest bearing. In this conclusion palæontology has, for the first time, spoken the decisive word in a purely botanical question."

The anatomical structure of plants was also receiving attention at the hands of other brilliant men, about the same time, chief among whom were Renault and Solms Laubach.

The more geological side of palæobotany was

that time growing rapidly as a result of the researches of Saporta, Heer, Ettingshausen, Lesquereux, and others. Heer in particular was doing work of world-wide fame in his discoveries of Arctic floras which indicated a once warmer climate for those now frozen zones. Nevertheless to some of Heer's work, and to many monographs published at the end of the nineteenth century, one might apply the following words, which, curiously enough, were published a hundred years before such work appeared. In 1784 Francis-Xavier Burtin said: "Malheureusement ceux qui découvrent un fossile, s'empressent trop de le nommer, et le mot je *l'ignore* paroit avoir été de tout temps dur à prononcer. De là cette quantité de noms absurdes, dont la science oryctologique parvient si difficultment à se débarrasser."

("Unfortunately those who discover a fossil are altogether too eager to give it a name, and the words: 'I don't know'—seem always to have been hard to say. Hence the great number of absurd names, of which it is difficult to rid the science of oryctology.")

To-day palæobotany has three sides; or rather, the new science slowly reaching out from the shelter of its step-parents botany and geology, is already a growth with three main branches, each of which bears fruits of value to three sections of the community.

First, to botanists. Reference has been made to some of the recent work of palæobotany as being indispensable to the science of modern botany. This is now recognized by every leading botanist, and Sir Joseph Hooker in a letter to Dr. Scott in 1906 wrote of our "knowledge of botany as it advances by strides under a study of its fossil representatives." From the study of the fossils one learns not only of whole genera, and even families of extinct plants, which help us to comprehend the relationships of existing types, but often the fossils exhibit complexities and novelties of character which not the most vivid imagination could have foreseen. For instance, what modern botanist, even in a delirious dream, could have conceived of a cone for the Lower Carboniferous Pteridophytes so complex as Cheirostrobus, the demonstration of the actual structure of which we owe to Dr. Scott? Then the existence in the past of the Pteridosperms, demonstrated by Prof. Oliver and Dr. Scott, is of profound importance to all botanists.

The modern botanist's conceptions of morphology, his definitions even of an organ like the seed, have undergone profound modification through the introduction of ideas based on fossils. *Only from the fossils can we learn the actual facts of evolution.* Connecting the botanist with the geologist is the plant-geographer. The history of Ginkgo, now an isolated species only found native in Japan and eastern China, but in Tertiary to Oolitic times widely distributed over Europe and America, illustrates with a single instance, the importance of the palæobotanical record for those who deal with the distribution of modern plants.

Asa Gray said: "Fossil plants are the thermometers of the ages, by which climatic extremes and climate in general through long periods are best measured"; and Charles Darwin, in 1881, wrote to Hooker: "The extreme importance of the Arctic fossil plants is self-evident."

Through the palæogeographer we come to the geologist. To what extent is he indebted to palæobotany? In this country, the British Isles, it has been so arranged by nature that there are no immense tracts of land composed of strata in which the only fossils are plants; had there been, possibly that survey post held by Hooker in 1846 would not have lapsed. If our geologists think they can get along without palæobotanists, let us hear what the Americans have to say.

There are twelve palæontologists altogether in the United States Geological Survey, and of these four are palæobotanists. Take the record of one of these geological palæobotanists, Dr. Knowlton; he says: "For the past five years I have annually studied and reported on from 500 to 700 collections, each of which embraced from one to hundreds of individuals, and with them have helped the geologists to fix perhaps fifty horizons in a dozen states."

Now let us turn to the third branch of my science. This is the practical side, and deals specially with coal-mining. In their rough and ready way, miners have "muddled along" without much help from palæobotanists. But with a collaboration between the two great advantages to both would accrue, and are to be looked for in the future. Palæobotanical information, to be of any value to the miner, must be very detailed and accurate. It represents the ultimate refinement of the stratigraphical work just mentioned as being the province of geological palæobotany. Fine and accurate zoning by plants has already been successfully carried on, however, particularly in France, where Prof. Zeiller, of Paris, or M. Grand' Eury, is called in consultation before most mining operations of importance are undertaken. Palæobotany is an intricate and independent science, which is now much vaster than is realized by more than a few people. To illustrate the enormous

mass of detail with which a conscientious palæobotanist has to cope, it is only necessary to turn to Dr. Jongmans's *résumé* of the publications for the year on the subject. It is 569 pages long, and on each page are, on an average, twenty-one entries. But this invaluable work has only been published for the last three years. For everything before that we have no centralization of results.

What will the palæobotanist of the future demand?

That in at least *one* institution in each civilized country there shall be a recognition of his science and adequate accommodation for it. This institution would form the headquarters, the centralizing bureau, for all the branches of work in which the individual palæobotanists may be specializing whether as geological palæobotanists, botanical palæobotanists, or practical miners. In this central department should be kept standardized collections of fossil plants. In this central department also should be available herbariums and immense series of sections of modern plants with which to compare the fossils while working on the botanical elucidation of their structure. As things are to-day in any new branch of palæobotany, the modern botanists do not provide exactly the kind of data wanted for comparison by the palæobotanist. This is noticeably the case, for instance, in the study of early fossil Angiosperms. No modern botanist can show us the preparations of living Angiosperms that are essential for our researches.

Then, too, in this central department of the science would be collected together, not only all the literature on palæobotany, but this literature would all be indexed, analyzed, and made available on several series of card catalogues. The work done by Dr. Jongmans for the last three years must be done for the last 150 years, and put in the handiest form for reference, which is, of course, a card catalogue. Then there must be a complete card index of all the names ever given to fossil plants. At present, most palæobotanists, all indeed, save a very few, tend to despise questions of nomenclature, but our science is in a very bad way owing to the immense numbers of names given on insufficient or wrong grounds. One cannot emphasize too strongly the urgent necessity for palæobotanists to reduce order from the chaos of their present nomenclature, and this can only be done by some centralizing institution or committee, who are sufficiently grounded in the science to realize the special needs of palæobotany.

Beyond all this it must not be forgotten that the collections of fossil plants at present made are trivial in comparison with those which will have to be made from all parts of the earth before we can completely unravel the histories of the ancient continents, solve questions of past climates, restore the details of innumerable extinct floras, and reconstruct the tree of plant evolution through the ages.

In spite of all the discoveries of palæobotany immense problems still lie unsolved. Darwin said, in a letter to Hooker, "The rapid development, so far as we can judge, of all the higher plants within recent geological times is an abominable mystery." To-day it is an abominable mystery still, and an abominable mystery it will remain until palæobotany is recognized as an independent science, and housed, endowed, and equipped so that she has the tools she needs for her work.—*Nature.*

Electrified Chickens—Electricity as a Growth Stimulator

By the English Correspondent of the Scientific American

SOME time ago Mr. H. G. Wells wrote a delightful fantasy called "The Food of the Gods," in which he imagines a food which stimulates growth to such an extent that the dimensions of all living things who feed upon it are increased six or seven times. Mr. Wells probably had no suspicion that such a stimulating agent would ever be discovered. But it appears as the result of some very recent researches, that living beings may be greatly increased in size when subjected to proper conditions. It is true that no mysterious food has been discovered which stimulates growth in this way. The stimulating agent is electricity, to whose powers, both beneficent and harmful, there appears to be no end.

High frequency currents have long been used by the medical profession with beneficial results, but until recently the mere fringe of the subject has been touched. Medical men have been contented with a comparatively limited range of application. It has been reserved for Mr. T. Thorne Baker to show great possibilities are inherent in the application of high frequency currents to living things. For some time Mr. Thorne Baker has investigated the effect of electricity upon the growth of bacteria and mosses, but his latest work, apart from its scientific interest, promises to have results of great commercial importance. The latest experiments are concerned with the influence of high frequency currents upon the growth of chickens, and they are being conducted upon a truly colossal scale. Meeches Farm, Poole, England, is probably the greatest chicken farm in the world, and is the scene of these new experiments. On this farm

about four thousand chickens are being grown under the influences of the electric waves. The results are truly astonishing. The chickens live in flats and over the whole building is wound an insulated wire which is traversed by the high frequency currents. The apparatus which generates the high frequency currents presents distinct peculiarities from the electrical point of view, and is the outcome of numerous experiments. Careful adjustments have to be made of the various electrical quantities entering into the circuit, before any effect is produced, but with a proper adjustment of the apparatus, most marked effects occur.

Chickens living in the electrified flats reach, in five weeks, the normal weight of chickens three months old. And out of four hundred chickens treated in this way only six, and those obviously doomed from birth, died. In view of the fact that a fifty per cent death rate is usual at this period of the year, it will be seen that this result is sufficiently startling. Chickens so weak that they could not stand up, and who in the ordinary course would infallibly have died, have been put in the electrified flats and become healthy and strong.

It is not only that the output of a chicken farm is doubled by this process, but a considerable saving in food is effected. Only two thirds of the usual quantity of food is required by the electrified chickens.

The chickens are charged to such a high potential that a spark discharge occurs on presenting a finger to the beak. From the scientific point of view the most interesting part of this work is the theory which explains *how* high frequency currents stimulate growth in this way. Mr. Thorne Baker is of the opinion that the high frequency currents stimulate the blood circulation by lowering the viscosity of the blood. He has conducted experiments on the effect of high frequency currents on the flow of viscous fluids, and he finds that the time of flow is decreased. The viscous fluid loses some of its viscosity and becomes more mobile.

It is not at present known whether prolonged electric action increases growth up to maturity, or whether its whole effect is to cause the maximum size to be sooner reached.

It certain quarters the application of high frequency currents to the growth of children is being contemplated, and the results in this field will be awaited with interest.

It is evident that we have here a method pregnant with possibilities, and its further developments will be rich in interest both in their scientific and commercial aspects.

Gasoline Substitutes

INCREASED supplies of gasoline are now obtained by compressing natural gas so as to condense pentane and hexane, a very light spirit being produced which is suitable for mixing with a heavier spirit to render the latter sufficiently volatile for use in carbureters. Oils of specific gravity 0.8, or a mixture of such oil with 40 to 60 per cent of gasoline, can now be used in special carbureters fitted with a supplementary feed tank containing gasoline starting. The heavier fractions of crude petroleum are converted into motor spirit by "cracking" in contact with iron, and an increase of 39 per cent in the yield is obtained. The quantity of benzene available for motor spirit from gas works tar in England is only 50,000 gallons per annum, and it is doubtful whether motor spirit can be obtained profitably by distilling coal at low temperatures and "cracking" the naphtha distillates obtained from the tar. The maximum yield obtained at present is 3 gallons of motor spirit per ton of coal carbonized in coke ovens. The only motor spirit obtainable in unlimited quantities is alcohol, which could be made for the purpose and sold at one shilling (25 cents) per gallon.—*London Times.*

A Cure for Sleeping Sickness

THE researches of learned men concerning one of the most terrible diseases of the Black Continent, the sleeping sickness, have very much increased during the last few years, without, however, any definite result having been obtained. In a paper recently presented before the Academy of Sciences by M. Laveran, M. Danyez, of the Pasteur Institute, signals the fact that, in the treatment of trypanosomiasis, it is advantageous to make use of several medications, not one alone being sufficiently energetic to cure the disease. Thus, the simultaneous employment of several arsenical combinations, such as arsenious acid, orpiment and atoxyle, gives very interesting results. M. Danyez has tried to obtain a solution of arseno-benzol and nitrate of silver. This combination has had a very energetic action on animals attacked by trypanosomiasis. In *surra* and in trypanosomiasis occasioned by the spirilla of Rhodesia—the same microbe as that of the sleeping sickness—exceedingly remarkable results have been obtained with very small doses of arseno-benzol and nitrate of silver. A single injection of one twentieth part of a milligramme has sufficed to cure a mouse weighing 20 grammes, and rabbits weighing 2 or 3 kilogrammes were cured by a single intra-venous muscular injection of 5 milligrammes.—*Chemical News.*

NEW BOOKS, ETC.

WAR TIME IN MANILA. By Rear-Admiral Bradley A. Fiske, U.S.N., of the U.S.S. "Petrel" and "Monadnock" during the War. 275 pp.; numerous half-tone illustrations. Boston: Richard G. Badger, Tħe Gorham Press.

It is many years since Dewey sailed into Manila Bay and fought the memorable action with the Spanish fleet; but it is not so long ago that the more intimate incidents of that action and of the events succeeding as told by a personal eyewitness fail to have a fascinating interest for the reader. Much has been written about the naval and military campaign in the Philippine Islands; but we doubt if any work has appeared which carries such a personal and intimate touch as the simply and very graphically written account contained in this volume.

Many people have wondered how the fighting man feels in the moments preceding his entry into battle, and this volume gives us, here and there, an illuminating insight to the psychological side of this interesting question, as note the following, describing the night hours immediately preceding the battle of Manila Bay: "I found the wardroom absolutely dark. Then I felt my way to my own room and lay down on my bunk. The deck above my head was distant about two feet, and I thought how very flat I would be squashed out against that deck if a torpedo exploded under the ship." Fiske's position during the engagement was probably one of the best points of vantage from which to view the battle with Admiral Montojo's little fleet of gunboats. Says he: "There was not even a conning tower on the 'Petrel,' so I had rigged up a platform on the foremast about forty-five feet up, where I could sit with my stadimeter above smoke and measure the range of the enemy and inform the captain of whatever important incidents or movements my clearer view might enable me to see." Says the writer: "About the decks of the 'Petrel' things were entirely different from what I had expected. I had seen many pictures of battles and expected great excitement. I did not see any excitement whatever. The men seemed to me to be laboring under an intense strain and to be keyed up to the highest pitch, but to be quiet, and under complete self-control, and to be doing the work of handling the guns and ammunition with that mechanical precision which is the result we all hope to get from drill." Admiral Fiske criticises the Spaniards for not putting their fleet under the batteries of Manila, where four powerful modern 9.2-inch guns were mounted; guns which if properly handled, could have sunk the whole of the American fleet. "Anyone of these guns would have sunk our vessel or disabled the other ships." The work deals in the most interesting and illuminating way not merely with the sea-fight itself but with the operations, naval and military, which followed Dewey's victory. Anyone who wishes to get an intimate view of naval life, as seen from the standpoint of an unusually intelligent and observant naval officer who has the gift of looking below the surface of things and analyzing what he sees with a philosophical mind, will do well to purchase this most interesting work.

ANATOMY, DESCRIPTIVE AND APPLIED. By Henry Gray, F.R.S. New (American) Edition, Thoroughly Revised and Re-edited, with the Ordinary Terminology Followed by the Basle Anatomical Nomenclature, by Edward Anthony Spitzka, M.D. Philadelphia and New York: Lea & Febiger, 1913. Imperial 8vo.; 1,502 pp.; 1,225 large and elaborate engravings. Price, cloth, $6 net; leather, $7 net.

This beautiful book before us is a marvel of completeness, and is one of the handsomest pieces of scientific book-making which we have ever seen. Color is frequently used throughout the book, not in the form of plates, but as an aid in illustrating anatomy by means of colors surprinted on the illustrations themselves. Thus on page 132 is a lateral aspect of the individual skull. We find eight colors surprinted on a wood cut. This is a great help to the student, and also to the general reader who may care for a splendid work on anatomy for library use. Gray's Anatomy has for over fifty years been the best-known work in all medical literature. Measured by the number of students, physicians and surgeons who use it, and by the way in which they keep it and constantly refer to it, it is incomparably the greatest textbook in medicine. The revision for the edition has been very thorough. A feature in which Gray has always been unique—the engraving of the names of the parts directly on the illustrations—is carefully preserved. The student is thus enabled at a glance to visualize the name of the part, its position, extent and relations, thus photographing in the memory knowledge otherwise painfully difficult to retain. A superb index comprising both terminologies in a single alphabet completes all the service which it is possible for a book to render. Its combination of unrivaled engravings and an incomparably clear text, reflecting the life-work of many of the world's masters of anatomy, and its peculiar quality of presentation which facilitates to the utmost the acquisition and retention of a sound knowledge of its subject, have maintained it in the premier position of all textbooks on

anatomy for over fifty years, and it was never stronger in attraction or further in advance of its competitors than in this new edition. The book will prove useful in any library, public or private.

FREIGHT CLASSIFICATION. In Four Parts. By E. R. Dewsnup, Professor of Railway Administration, the University of Illinois. Chicago: LaSalle Extension University, 1913.

ATLAS OF RAILWAY TRAFFIC MAPS. By William Arthur Shelton, A.B., A.M. Chicago: LaSalle Extension University, 1913.

The utilitarian, cultural, and professional courses of the LaSalle Extension University are widely and favorably known. Of especial modern appeal is this offering in the way of a practical traffic course. The four textbooks here listed, together with the atlas, provide adequate instruction in this branch of economics. Lesson Assignment 1 covers the technique of American freight classification. Assignment 2 is devoted to a comparative study of classification rules and of the trend toward uniformity. Assignment 3 sets forth the principles of rate theory. Assignment 4 is a compendium of information on territorial and technical traffic terms, the abbreviations in common use, and test questions. The textbooks have been very capably prepared, and a word of praise must be accorded the atlas, which stands as the first attempt to portray fully and accurately, by means of specially prepared maps, the freight adjustment territories of the United States and Canada. Modern transportation by rail opens up splendid opportunities for competent traffic men and interstate commerce experts. It provides lucrative and fascinating occupations of ever-widening demand.

A LITERARY AND HISTORICAL ATLAS OF AFRICA AND AUSTRALASIA. New York: E. P. Dutton & Co., 1913. 16mo.; 218 pp.; 134 maps. Price, 35 cents.

The present volume completes the survey of the world upon which "Everyman's Library" set out in a series of special volumes, five in all, some seasons ago. The extent of the land and sea that it covers, between the extremes of Algiers and Samoa, is immense in latitude and longitude; while in point of history it ranges from the oldest to the newest civilization; as suggested by Karnak, or the new capital of Australia, Canbena. Moreover, in accord with the general idea of these map-books, the effect of the map in illustrating history, the growth and multiplicity of peoples and cities, and the vast possibilities of unworked regions, is kept in sight throughout these pages. It is marvelous that such convenient and accurate Atlases can be supplied for a small sum of money. In other words, for less than two dollars, anyone can obtain an atlas of the world in five volumes containing monographs on coins together with maps and plans of notable battles, districts, etc., connected with foreign authors and their books. There is an excellent Gazetteer in each volume, as well as an index. The series is a most admirable one.

THE AUTOMOBILE BLUE BOOK. Vol. I. New York and Canada. New York: Automobile Blue Book Publishing Company, 1913. Price, $2.50.

"The object of a journey is not only to arrive at the goal, but to find enjoyment on the way." What motorist but has some time or other found himself, or lost himself, in a maze of wretched and unfamiliar roads, with the natives either so stupidly taciturn that they cannot or will not convey the desired information, or else so vaguely voluble that you cannot follow their involved directions? The remedy, the assurance of "enjoyment on the way," is to be found in the use of the Automobile Blue Book. Your odometer and the Blue Book in conjunction will make plain to you every turn and fork in the network of roads that covers the Empire State, smoothing the way to Niagara, to the Thousand Islands section, to and through the Adirondacks and the Catskills, or along the shores of the Great Lakes. Re-mapped and re-written, this volume embodies the changes and the bettered conditions of New York's highways, and includes wherever possible the tourable roads that extend through the Province of Ontario. Those who desire to taste the exhilaration of New York's mountains and shores and countryside, with a minimum of mental strain and physical fatigue, will find in this volume a friend in need and a friend indeed.

LA RESISTENZA DELLE ARTIGLIERIE. Nuovi studi degli ingegneri Leone Coupaye e Pietro Malaval dell 'Artiglieria navale francese. Traduzione e prefazione di Ettore Bravetta capitano di va scello R. N. Torino: Carlo Pasta, 1913. 8vo.; 262 pp. Prezzo del volume: L. 8.

The researches of this volume lead to several interesting facts and deductions. Wire-wound guns are condemned, and their great resistance is denied as legendary. In calculating resistance, tangential dilatations have generally been taken as a basis, and the importance of the radial deformation has been generally neglected. When relatively high pressures are required it is absolutely necessary that radial deformation be taken into consideration. Attention is called to the fact that the elastic resistance of a gun is directly limited by the elasticity of the metal

forming the internal tube. Engineer Malaval demonstrates the possibility of constructing guns which will support a pressure of 10,000 kilos per square centimeter without permanent deformation.

THE GYROSCOPE. By F. J. B. Cordeiro. New York: Spon & Chamberlain, 1913. 8vo.; 105 pp. Price, $1.50.

The theory of gyroscopics is neither simple nor as yet complete. Its literature is scant and scattered. For this reason the author of the work in hand has sought to present the theory and applications of the gyroscope within one slim volume and in as simple a fashion as possible. However, an elementary knowledge of mechanics and the calculus will be found indispensable. As the motions of the heavenly bodies are the noblest and freest expressions of gyroscopic law, a discussion of their actions and orbits is admitted to the volume. But this may be ignored by those whose interest is in the elementary theory alone. Gyroscopic action is explained as the result of compound centrifugal force, and among the few practical applications so far realized may be named the Brennan monorail, the Obry and Howell torpedo devices, and the Schlick "stabilisator" for the steadying of ships.

LIGHTSHIPS AND LIGHTHOUSES. By Frederick A. Talbot. Philadelphia: J. B. Lippincott Company, 1913. 8vo.; 325 pp.; illustrated. Price, $1.50 net.

Everything pertaining to lighthouses, lightships, buoys, and submarine bells—everything, that is, which can possibly be of popular interest—is covered by Frederick A. Talbot's latest volume. The romance of the subject has not been lost sight of, and stories of adventure alternate with descriptive passages. Problems of construction are so explained as to leave the reader with a keen appreciation of the apparently insurmountable difficulties that have finally been overcome. Lighthouses in all parts of the world, many of them in Canada and the United States, are described and illustrated. Lights and sirens and fog-guns are dealt with, too, and each nation's peculiar methods of coast lighting is discussed at some length. Among the lights of our own land, that of Minot's Ledge off Boston harbor receives its meed of praise as one of the greatest works of the American builder.

POLAND OF TO-DAY AND YESTERDAY. A Review of its History, Past and Present, and of the Causes which Resulted in its Partition, Together with a Survey of its Social, Political, and Economic Conditions To-day. By Nevin O. Winter. Boston: L. C. Page & Co., 1913. 8vo.; 349 pp.; 48 illustrations. Price, $3 net.

To the sentimentalists who put unrestrained individuality above the welfare of society, the author advises a study of Poland and her downfall. In a brief preface the causes of her humiliation are sketched; and the author urges the study of the present-day Pole in the light of his ancestry and environment. Chicago has more Poles than any other city of the world except Warsaw. The Pole is a large and growing factor in American life, and his problems are the problems of the American people. The work in hand is a popular history of his home land and his home people, from the inception of a national spirit to the conditions of to-day. Its relation to the character of a large body of future Americans adds to the work's value. No knowledge should be neglected that may lead to a better understanding of our immigrants and their more judicious handling, and hence to a more efficient assimilation.

THE ART OF THE WALLACE COLLECTION. By Henry C. Shelley. Boston: L. C. Page & Co., 1913. 12mo.; 334 pp.; illustrated. Price, $2 net.

The Wallace Collection of London has been open to the public for thirteen years. In that time it has won remarkable favor from two extremes of taste, the popular and the critical. Its treasures, which are now by the generosity of Lady Wallace, the property of the nation, fully deserve praise from any and every point of view. Mr. Shelley's text and the accompanying pictures, or should we say pictures and the accompanying text? have been prepared with all the discriminating care of his earlier works on art and architecture. His critical comments are very brief, but to the point, nor are they weakened by any hesitation in expressing personal conviction. Even to name the masterpieces reproduced in Mr. Shelley's volume would far outrun our space, and it must suffice to say that from one gallery, gallery 16, alone, come canvases with such rare names as Titian, Velasquez, Murillo, Reubens, and Rembrandt. The duogravure reproductions of famous paintings are for the most part clear, and possess sufficient color-suggestion to enable the reader to visualize some of the values of the originals.

CABINET TIMBERS OF AUSTRALIA. By R. T. Baker, F.L.S. Sydney, N. S. W.: Technological Museum, 1913.

This beautiful folio has more than fifty full-page illustrations in color, showing the cabinet woods of Australia. These are supplemented by many plates in black and white picturing some of the many artistic ways in which these woods are utilized. This folio should appeal not only to cabinet-makers, but also to students in various branches of decorative art, and to

all who appreciate art and nature. The trade will turn to it for information as to the specific characteristics of cabinet timbers and the locality where the trees are found. A botanical description accompanies each example. The author is Curator of the Technological Museum and, wondering whether these timbers may not shortly become "as extinct as the dodo," he trusts that his work may at least serve as an historical record of the varied and valuable resources of Australia's forests.

CRANES AND HOISTS. Their Construction and Calculation. By Hermann Wilda. Translated from the German and adapted to British Practice by Charles Salter. London: Scott, Greenwood & Sons. New York: D. Van Nostrand Company, 1913. 16mo.; 159 pp.; 399 illustrations. Price, $1.25 net.

The first section of the work deals with lifting tackle, the second with cranes and hoists. The various types of cranes and the determination of stresses are made clear by the many sketches that accompany the text. There are tabulated data for calculation, for oval and like link chains, and data for design of plate girders, and a detailed index gives ready access to any subject of the work.

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

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